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MR. FREDERICK HOBART is no longer connected with this paper as Associate Editor nor in any other capacity.

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EDITORIAL NOTES.

THE Coupler Bill, which has passed the Senate, a full text which we give in another column, contains one feature which seems to have been almost an oversight. Authority is given to the American Railroad Association to fix the standard height of the draw-bar and also to decide what variations above and below this standard will be allowable. And there is nothing to prevent them from taking the height of the draw-bar of the highest car empty as the upper limit and that of the lowest car loaded as the lowest, which would leave matters just as they are and perhaps a little worse.

IT is a curious commentary on the slowness of apprehension of the City Fathers of some of our near-by cities to note that, whereas there was a tremendous opposition to the elevation of the tracks of the Pennsylvania Railroad in Jersey City, on the ground of inconvenience and damage to property, now the improvement has been recognized as being such a decided success that there is a very serious talk of compelling all of the other railroads entering the city to do the same thing. It would certainly be greatly to the advantage of all the parties interested, both in the railroad properties and the adjoining real estate, if this were done, but the problem of raising the money would be a very serious one for some of the roads to face.

IN an article published in another column there is an interesting statement of the amount of work which is now being done in the ship-building yards along the Great Lakes. The industry certainly seems to be in a very flourishing condition, and all of the yards are busy to their full capacity, which argues well for the development of the transportation facilities and interests between the northwest and the sea coast. And these will undoubtedly receive still further impetus if Congress makes an appropriation for the formation and maintenance of a deep-water channel between the headwaters of Lake Superior and the Hudson River.

GAUGE OF WHEELS AND RAILS.

ON another page we give a condensation of a very excellent paper on Wheel Flanges, which was read before the Western Railway Club by G. W. Rhodes, Superintendent of Motive Power of the Chicago, Burlington & Quincy Railroad, on January 17, 1893. The main purpose of that paper was to show the importance of having a maximum gauge for the thickness of the flanges of car-wheels, as well as a minimum one, which has already been adopted by the Car-Builders' Association.

The subject of wheel gauges and wheel flanges has often been discussed before that Association, and action of various kinds has been taken with reference thereto. To obviate the danger resulting from running wheels whose distance between the backs of their flanges is less than that over the guard-rails and wing-rails at frogs, a standard distance of 4 ft. 5 in. over those rails was adopted in 1882, and of 4 ft. 5⅜ in. between the backs of the flanges of the wheels was adopted in 1883. In 1885 the latter was modified so as to allow of a variation of ⅛ in. each way, making the maximum distance between flanges 4 ft. 5½ in. and the minimum 4 ft. 5¼ in.

The difference in the forms and thickness of flanges was often so great, however, that in many cases, if the standard distance between their backs was maintained, the distance between the outside of the flanges, where they come in contact with the rails, was greater than the distance apart of the latter. The importance of having a standard form and sizes for the flanges of wheels thus became apparent, and in 1886 such a standard was adopted, which is now generally known and used.

In the inspection of cars it became important, too, to be able to determine definitely when a flange was worn sufficiently to be condemned. To meet this requirement, the Car-Builders' Association adopted a minimum gauge for the thickness of flanges, and when they are worn enough as to enter this gauge, they are condemned. The necessity for a maximum gauge never seems to have occurred to any one until Mr. Rhodes pointed it out.

There are, however, many complications which have a bearing on the important matter of wheel and track gauges. In order to point these out "so as to be understood of all men," the subject will be discussed here in a somewhat elementary way. The most serious and important incongruence relating to this subject is the fact that the gauge

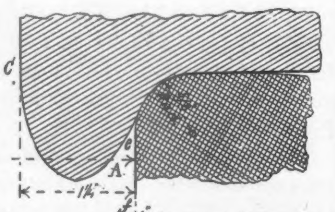
of the tracks of the Pennsylvania system of railroads is 4 ft. 9 in., while that of nearly all the other roads in the country is 4 ft. $8\frac{1}{2}$ in. In any system of gauging wheels this paramount fact must always be kept in mind and provided for.

Then, too, the form of the rail heads has an important bearing on their relation to the wheels, and is the cause of much confusion and what may be called indeterminateness. In Mr. Rhodes's paper he says:

"The Master Car-Builders' standard, as shown in fig. 7 (in his paper), is usually estimated as measuring $1\frac{1}{4}$ in. through the flange (some would call it $1\frac{3}{8}$ in.); with the same method of reckoning, the thick flange measures a strong $1\frac{3}{8}$ in. (some would say $1\frac{1}{2}$ in.)."

It will thus be seen that if it be assumed that the maximum dimension named by Mr. Rhodes represents the thickness of the Master Car-Builders' standard flange, it will, apparently, make a difference of $\frac{1}{4}$ in. in the gauge of the wheels, compared with what it would be if the minimum dimensions were taken as the thickness. The fact is that the thickness which should be taken in computing the gauge, or what may be called the working thickness, is influenced very much by the form of the rail-head. Thus fig. 1 (herewith) represents a section of the Master Car-Builders' flange, in contact with a rail-head, the corner of which is rounded with a radius of $\frac{5}{8}$ in. The gauge of the rails would be measured on the line A, $e\,f$ being the gauge-line. It will be seen that the back, C, of the flange projects $1\frac{1}{4}$ in. from the gauge-line, and practically represents the thickness of the flange. In fig. 2 the corner of the rail-head is rounded with a curve having a radius of $\frac{1}{4}$ in. The back of the flange then projects $1\frac{7}{16}$ in. inside of the rail-head, and this dimension represents the thickness of the flange if used on rails of this form.

Fig. 1.



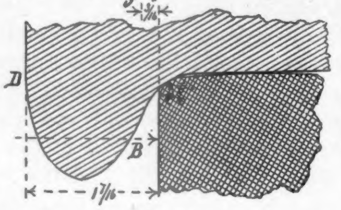


Fig. 2.

In some cases the gauging of the rails also has an important influence on the gauge of the wheels. In fig. 3 the section shaded in full lines represents a form of rail-head introduced about 10 years ago quite extensively, but which has since been modified somewhat in its shape. It is introduced here merely to illustrate what we are trying to explain. It will be seen that the sides of this rail-head have considerable outward slope or inclination. Modifications of this form of rail-head are extensively used, but there is no common agreement with reference to the point from which the gauge is measured. In some cases it is measured on a line A, where the side of the head joins the curve of the corner, and in others it is measured at B, the widest part of the head. In the one case the practical thickness of the flange is $1\frac{1}{4}$ in.; in the other, $1\frac{5}{32}$ in. Let it be supposed that the rail is made of the form shown by the area C, fig. 2, which is shaded with dotted lines, and that the dotted outline represents a Master Car-Builders' standard flange in contact with such a rail. The practical working thickness of the flange would be as in fig. 2, $1\frac{7}{16}$ in., as shown at $e\,f$. If compared with a flange in contact with a rail of the form represented by the full lines, and gauged from B, there will be a difference of $\frac{1}{4}$ in. in the practical working thicknesses of the flange.

This may be illustrated in another way. Supposing that a pair of wheels were gauged in accordance with the Master Car-Builders' maximum standard—that is, with a distance of 4 ft. $5\frac{1}{2}$ in. between the backs of the flanges. If, now, we add to this twice the working thickness of the flange shown in fig. 2, and we will have $4' - 5\frac{1}{2}'' + 1\frac{7}{16}'' + 1\frac{7}{16}'' = 4' - 8\frac{3}{8}''$. With a gauge of 4 ft. $8\frac{1}{2}$ in. the wheels will, therefore, have a total of only $\frac{1}{8}$ in. end play or $\frac{1}{16}$ in. on each side.

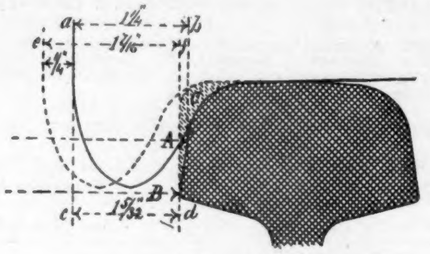


Fig. 3.

If we take a pair of wheels with flanges with a working thickness of $1\frac{5}{32}$ in., as represented at cd, in fig. 3, and rails of the form shown by the full lines in this figure, and gauged 4 ft. 9 in. at the point B, and assume that the wheels are gauged to the minimum Master Car-Builders' standard distance—4 ft. $5\frac{1}{4}$ in.—between the backs of their flanges, and we will have $4' - 5\frac{1}{4} + 1\frac{5}{32}'' + 1\frac{5}{32}'' = 4' - 7\frac{9}{16}''$, so that in a 4 ft. 9 in. gauge, with rails like that shown in fig. 3, such a pair of wheels would have $1\frac{7}{16}$ in. total end play. It will thus be seen that wheels may conform entirely to the Master Car-Builders' standard, and yet on some lines of railroad have only $\frac{1}{8}$ in. total end play, while on others they will have nearly or quite $1\frac{1}{2}$ in. This difference is due entirely to the forms and methods of gauging rails.

Nor is this all that may be said. As long ago as 1877 Mr. Samuel J. Hayes, then Superintendent of Machinery on the Illinois Central Railroad, took a pair of car-wheels and turned off the inside or backs of the flanges, so as to have true surfaces. The wheels were then put under an eight-wheeled car. Quoting from a report made at the time, it was said:

"Six measurements were then taken between the flanges at the top and at a similar point at the bottom of the wheels, under different conditions. In some cases, after the measurements were taken, the car was pushed along the track until the wheels had made half a revolution. The second measurement did not differ from the first. The record of experiments given below represents the difference of the distance between the flanges at the top of the wheel and at the bottom. All possible care was taken to have the measurements correct:

"With weight of truck only,	$\frac{1}{64}$	in. full
" " " car body only,	$\frac{3}{64}$	" "
" load of 10,000 lbs., all in one end over wheels measured,	$\frac{6}{64}$	" "
" " of 20,000 lbs., evenly distributed in car,	$\frac{7}{64}$	" "
" " of 25,750 lbs., evenly distributed	$\frac{8}{64}$	" "
" " " 36,000 " " "	$\frac{9}{64}$	" "

"As the experiments were made with the loads at rest, it is evident that under the violent concussion to which an axle is subjected in use, the spring or deflection must be very much greater than that given above."

The axle was of smaller size than is now ordinarily used—the journal was $3\frac{1}{4}$ in. diameter, the wheel-seat $4\frac{1}{2}$ in. and the middle of the axle $3\frac{13}{16}$ in., but the loads also were only about one-half what are now hauled.

It would be an interesting contribution to our information on this subject if some one would devise an apparatus which would show the spring of axles while the cars are running. This would not be very difficult to do, and would throw much needed light on this important subject; but Mr. Hayes's experiments alone show that the distance between the backs of flanges and their outside gauge is materially effected by the spring of the axles.

The deduction from Mr. Rhodes's paper and a consideration of the subject are:

1. The importance of establishing a maximum gauge for the thickness of wheel flanges.

2. The necessity for a standard form for the heads of rails and for the method of gauging them.

3. The great desirability of having a common gauge for rails on all our roads; or, in other words, the abandonment of the 4 ft. 9 in. or the 4 ft. 8½ in. gauge, or both. Probably an assimilation of these two gauges can only be brought about by a compromise. It is suggested that if the standard gauge of the country was made 4 ft. 8¾ in., it would not be difficult for the roads with either 4 ft. 8½ in. or 4 ft. 9 in. gauges to conform to it. If the American Railway Association should agree that all rails on straight-line track should thereafter be laid to 4 ft. 8¾ in. gauge, the desired result would speedily be reached. As Congress has just legislated on the subject of couplers and brakes, they may, in the near future, see proper to exercise their authority to secure a uniform gauge of track for the whole country.

All or nearly all cars must now run on both the gauges, so that there could be no difficulty in running on a gauge intermediate between the two.

There will probably be more difficulty in securing the adoption of a standard form for the heads of rails than there will be in assimilating the gauges. There seems to be something about the occupation of a civil engineer which prevents him from assenting, conforming or agreeing to any common action or acting in compliance with the views of other people. The reason for this seems to be that in the performance of his duties he generally acts alone. Usually he does not work in accordance with or for the object of suiting other people's ideas. He usually works to please himself alone. He does not make goods to sell to others, and therefore he is not obliged to act in compliance with their views and wishes. The selling of goods cultivates flexibility of character as nothing else will. At the time the Master Car-Builders' Association was considering the question of the gauge and the form for the flanges of wheels, a general invitation was sent out to those in charge of the permanent way of roads to attend the meetings and take part in the discussion. One solitary individual responded to the invitation. Owing to the characteristic of civil engineers which has been pointed out, and to the fact that there is no association through which they can act efficiently, there does not seem to be any hope that a standard form for rail-heads will be adopted unless the American Railway Association should take up the subject and act on it. It is to be hoped that this will be done at an early date.

TRIALS OF THE "VESUVIUS."

The daily papers have been giving more or less obscure reports of the tests of the dynamite gun on board the *Vesuvius*, which have been carried on at Port Royal, S. C. From these reports it might be inferred that the gun and the vessel have been doing about everything that could be expected of them excepting the one thing for which they were especially intended—that is, firing shells loaded with dynamite. On February 2 we were told that the tests of the gun were not continued because "the work done on Tuesday and Wednesday did not quite agree with what had been accomplished in the days previously devoted to ranging the guns. The questions arising relate to the advisability of beginning the firing with the vessel under way without further stationary practice. As there are still about a dozen *unloaded* projectiles remaining in the firing room and projectile racks of the *Vesuvius*, it is probable that they will be fired to-morrow from the vessel in her present position—that is, moored alongside the wharf."

"Captain Rapieff, of the Russian Service, who represents the Dynamite Gun Company, is expected to arrive to-morrow with the fuses and primers required to perfect the mechanism of the loaded projectiles. It is proposed to fire a number of shells, or, rather, aerial torpedoes, *with about* 10 *lbs. of gunpowder* in their magazines. This will be done to test the action of fuses before using them with the more powerful explosives."

On February 5 we are informed that the fuses have arrived; but as the inventor has not yet secured a patent for them, "it is difficult to obtain an intelligible description of their mechanism. . . . The firing of *dummy shells*, six of which remain, will be resumed to-morrow."

On the 6th the reporter for the New York *Times* said: "The winds blew and the rain descended," and "through the heavy fog of the early morning the thundering reverberations from the *blank charges* with which the guns of the *Vesuvius* were being lubricated were wafted on a biting sea wind across Port Royal and then echoed along the northern shore as far as Beaufort." Other equally fine writing follows this; and we are told that "last week the shots were all successful *to a greater or less degree.*"

The public is also gravely informed that "the Board has been greatly desirous of attempting to catch one of the falling projectiles in a fish net. They brought one up from the *Philadelphia* last week, and have been looking for a chance to use it ever since. Until this morning, however, the net was ignominiously resting on the corner of the Navy Yard docking. It was taken down to the 2000-yard line this afternoon and adjusted in the river by means of boats. Before the shell was fired, however, the boats and net were both swept away by the tide, and the effort to use the net will be permanently abandoned."

Then we are told: "After more than a week's suspense, the public curiosity over the tests with loaded shells" (loaded with what?) "will begin to-morrow. The five *gunpowder shells* will be placed in the gun-racks to-morrow morning. . . . The lighter carrying the gun-cotton shells will *remain* at its mooring in Beaufort River, and will probably not be taken down the river until Wednesday morning. . . . Representatives of the press, however, will not be allowed on board the vessel during the tests with gun-cotton shells." (The public may regret that they were excluded.)

On the 7th the *Times'* vivacious correspondent tells the public that "Captain Rapieff arrived. It is now stated that after firing the gunpowder shells to-morrow the *Vesuvius* will go to the naval station and *prepare for the experiments with the gun-cotton shells.*"

On the 8th the information was given that "little work other than such as was relative to *future tests* of the *Vesuvius* guns was accomplished to-day. . . . Gunpowder shells will be fired to-morrow; but there is scarcely a hope that the experiments with the high explosives will begin before Monday next."

On February 9 "the execrable weather suspended the tests . . . Half a dozen more of the *wooden projectiles* were fired from the guns. . . . The real work of the day, however, consisted in assembling the parts of Captain Rapieff's wonderful and extremely intricate fuses. . . . Gunner Whitney inspected the high explosive shells and their charges of gun cotton during the day."

On the 10th "the *Vesuvius* resumed her practice." She fired five shots, but whether the shells were wood or metal was not told. They were, however, loaded with something, because one of them, it is said, exploded. Then follows this significant announcement: "Late this afternoon the *Wahneta* towed the lighter, loaded with projectiles, down to the *Vesuvius*, and seven shells were removed to the vessel's deck. *The gun cotton has been removed from these projectiles, and it will be replaced by gunpowder.*"

On the 11th four shots were fired, the shells being loaded with 15 lbs. of powder. The *Times'* observer says: "The ability of the tubes to throw a shell with an accuracy certainly not excelled, and possibly scarcely equalled, by powder guns, was demonstrated to the satisfaction of the observers. . . . The question of the efficiency of Captain Rapieff's fuse is just now far more pertinent and decidedly more doubtful. The

fuse is a wonderfully ingenious and intricate piece of mechanism, the practical results of which worked out beautifully on paper. . . . But grave doubts of its efficiency were suggested by yesterday's tests, when five shells were fired, and it was an open question as to whether any of them were exploded. To-day's experiments will increase the impression that the Rapieff fuse may possibly prove a failure. . . .

"It was unanimously agreed by the observers (the Board always excepted) that none of the shells exploded. The lateral line of their fall was practically accurate, and they were reasonably close to their mark; but it was evident that the fuse was not fulfilling its mission. . . .

"Captain Rapieff is very anxious for the tests with the shells loaded with 200 lbs. of gun cotton to begin. If the Board wants a visible effect, Captain Rapieff thinks they will get it then. The Board, however, seems inclined *to feel its way*."

The tests of the guns of the *Vesuvius* thus far seem to have been about as inconclusive as the experiments in rain-making down in Texas last year. A great many people are asking why they do not "shoot dynamite," which was the purpose for which the guns and the vessel were built.

NEW PUBLICATIONS.

Theory of Structures and Strength of Materials. By Henry T. Bovey, M.A., D.C.L., Professor of Civil Engineering and Applied Mechanics, McGill University, Montreal. 1893, New York: John Wiley & Sons. 8vo, 817 pages. Price, $7.50.

The numerous text-books on the mechanics of materials, and of roof and bridge structures published in the United States during the past twenty years, have indirectly had the effect of causing the writings of European authors to be neglected. Twenty years ago the works of Weisbach and of Rankine were extensively used as text-books in our technical schools. To-day Weisbach's books are almost unknown to the student, even by name, and those of Rankine, although still maintaining high rank as records of a master mind, are but occasionally consulted. American writers and teachers have produced a literature of their own, distinct from that of England, and but little influenced in later years by the publications of France or Germany. It may, indeed, be said that one of the weak points of many recent books lies in the neglect of European literature, although this has led to strength in other directions. American investigators and authors, if sometimes weak in theory, are often strong in rejecting theoretical speculations based upon insufficient assumptions.

The work before us bears evidence that its author has kept well abreast of the flood of literature produced on both sides of the Atlantic, and has utilized the strong points of each. The student who uses the book cannot fail to find the theory clear and sufficient, the practice sound and authoritative, and the two properly blended, so that each justifies and illustrates the other. At the ends of the chapters are given many problems to numerically illustrate the principles and methods; the student who can solve all these intelligently will have an admirable preparation for practical work as a constructing engineer. No doubt the author has carefully tested in the class-room most of the matter presented.

The book opens with a chapter of 92 pages on Framed Structures, in which graphic methods are mostly employed. Then are given 142 pages on Shears, Moments, and Strength of Materials, followed by 105 pages on Earthwork, Retaining-Walls and Friction. The subject of Beams, Columns, and Shafts occupies 246 pages; Bridges, 106 pages; Suspension Bridges, 37 pages; Arched Ribs, 72 pages, and there is a short chapter of 12 pages on Boilers. The range of subjects is wide, and both advantages and disadvantages occur in treating them all within the covers of a single volume. It would probably be preferable to allow such general subjects as work, energy, inertia, impact, friction and traction to be treated in general works on mechanics, rather than to devote space to them in a special book on structures.

In the graphical discussions of stresses in trusses the simple notation of Bow is not used, as is customary in both England and the United States, and we see no advantage whatever in the notation substituted by the author. The printer has sometimes failed to grasp the idea that a stress diagram and a frame diagram should be near together, and the confusion is increased when one is turned at right angles to another and is also on the opposite page, as occurs with figs. 86 and 87. The term "intensity of stress," often used in the early part of the book, seems not the best one for students; "stress per square inch" and, more simply, "unit stress" are preferable, and both are used in the latter part. The word "chord" and "flange" are generally employed in speaking of the horizontal members of bridge trusses, although now and then the (to American eyes) strange-looking word "boom" is seen. "Pillar" is often, but not always, used instead of "column." The Latinized plurals "formulæ" and "abscissæ" seem to be generally preferred to the English ones "formulas" and "abscissas." Rankine's theory of the lateral pressure of earth is given, although the assumptions at its foundation have met with little favor in the United States, and the author admits that it gives results too great for good practice. We note on page 634 a discussion entitled "Curve of Cantilever Boom," which seems obscure, for we have been unable to discover either its object or its result, and even the hypotheses (which the author says "are far from being approximately true") are not plainly set forth.

Criticism, however, is always easy, and in hinting at a few minor defects we do not wish to have forgotten our decided conclusion that the work is a valuable text book for students, and one that does much credit to its author for careful and painstaking investigations. Engineers will be interested in the new theory of the flexure of columns involving elliptic integrals, in the lengthy table of actual weights of plate girder and modern truss bridges, in the discussion of the stability of the stone arch, and in many other subjects. In theoretical investigations the book leans toward the methods in vogue in England; in numerical computations and comparisons, its tendency is toward American practice. In this union there is strength.

Annual Report of the Chief of the Bureau of Steam Engineering, Navy Department, for the Year 1892 Commodore George W. Melville, Chief of Bureau. Washington; Government Printing Office.

This report has less to say than some former ones of the designing of machinery for new vessels, the number whose construction was authorized during the year having been limited; but it nevertheless presents a record of a great variety of work accomplished in the construction of new engines and the care of older ones. It has some excellent recommendations for the improvement of the service and the betterment of the plants at the different navy-yards where the work has to be done.

The most important new work has been the designing of the engines for the new armored cruiser *Brooklyn* and the battleship *Iowa*, concerning which some interesting particulars are given. The main boilers of the *Iowa* will be the largest yet undertaken in this country; they are to be 16 ft. 9 in. in diameter and 20 ft. long, and the steel plates of the shell will be $1\frac{3}{4}$ in. thick.

Commodore Melville repeats in part some of the observations of previous reports on the weight of machinery, emphasizing his remarks by some instances from the experience of other navies. He finds an improvement in the matter of steel castings, but still believes that there is room for improvement.

The lack of an appropriation has prevented the Bureau from undertaking any experimental work during the year, but there is some work of this kind much needed. The Bureau espe-

cially desires to investigate the use of liquid fuel on board ship. The advantages to be gained by burning petroleum refuse or some similar fuel have often been urged, but it is still uncertain whether the use of such fuel on a naval vessel may not be attended by drawbacks which would more than offset the possible gain, and it is of some importance to ascertain the facts.

The results of building the engines of some of the cruisers in the navy-yard shops have been favorable, and it is probable that more of this work will be done hereafter. Some additions to the plants at the different yards are needed, and the establishment of an additional station at the League Island yard is recommended as a valuable addition to our naval facilities.

A considerable part of the report is devoted to a very earnest plea for the relief of the working force of the engineers of the Navy by an addition to their number. Under the changed conditions of a modern vessel the old force is insufficient for the work actually required, and the conditions are growing worse every year. There is also urgent need of a larger and better force of machinists and petty officers in the engineer department than can be had under present regulations. On these points Mr. Melville speaks very strongly, but not more so than the necessities of the case require.

Atmospheric Resistance and its Relations to the Speed of Railway Trains; with an Improved System of Heating and Ventilating Cars. By Frederick Adams. Chicago; Tribune Building.

This book contains a description of the principles and construction of some inventions by the author to diminish the resistance of railroad trains by lessening the atmospheric resistance, and new methods of ventilating and heating them. The book is admirably printed and well illustrated, but is written in a rather bumptious, reportorial style. In the scientific part the author seems to have followed the practice of the old master mechanic in counterbalancing locomotive wheels, he "figgered awhile and then guessed at it."

The main burden of the book is that atmospheric resistance forms a very large part of the total train resistance, especially at high speeds—which no one doubts—and that this resistance would be very much diminished by enclosing the cars and locomotives in a sort of continuous vestibule—about which there may be a good deal of doubt.

The author says he has six patents which cover "three distinct features of railway train and locomotive construction, thus:

"1. Details of construction of a locomotive and passenger train designed to offer the least amount of resistance to the atmosphere.

"2. A system of ventilation in which the air, free from dust, grime and smoke, is admitted from the front of the train and distributed in suitable quantities through the cars.

"3. A system of car heating in which the hot air around the boiler and fire-box of the locomotive, now wasted, is carried back through the train and properly distributed to heat the cars."

One is disposed to make reply to all that is claimed, in the language of the Hibernian, "to say it is easy, but to do it?" Criticism would perhaps be out of place, because the author forestalls it by saying that his book "is not addressed to those alleged authorities and self-styled experts whose stupidity and ignorance have, for a generation, stood as a stumbling-block in the path of railway science." The critics are expected to stand aside and give the author and inventor a chance to sail in, which no doubt they will be quite willing to do.

White Lead: What We Know about It and Its Substitutes. *A Few Suggestions to Practical Men.* By Oliver D. Goodell. Detroit, Mich.

This little book of 57 pages is devoted to a discussion of the relative merits of white lead and zinc oxide for paints, and is an argument in favor of the latter. A few extracts will give a general idea of the scope of the discussion, which will doubtless interest both the users and manufacturers of paints. The author says:

"Will consumers continue to go forward blinded by hoary prejudice and tradition, and pay into the coffers of this gigantic 'Trust' their hard-earned money, simply because the article is truly and faithfully named Strictly Pure White Lead? Will they not at some future time be willing to buy an article which has more merit, which is more durable, which is sold at a fair figure, and is as truly and faithfully branded what it is—namely, a mixture of lead, zinc, and barytes? These are the questions to be met in the near future. We have assured ourselves that a mixture of lead, zinc, and barytes can be made which will cover better, dry as well, and spread as well as white lead, and while retaining its whiteness and gloss longer than strictly pure lead, will be more durable, and which can be sold at a price less than pure lead, and at a fair profit to the producer.

"We do not object to lead because it is lead; we object to its use in a pure state, because we know that the judicious mixture of other material renders it more durable. It is attempted to make it appear that white lead pure can stand alone, and that white lead pure alone is the only paint that will stand the crucial test of time.

"We take the position that we should not, while admitting that a suitable proportion of white lead has its advantages, admit that we must buy pure white lead for all uses, when we can obtain more durable results with a mixture at less cost.

"Zinc does not affect the oil chemically, but makes a superb mixture of great brilliancy and fineness mechanically.

"It does not injure colors, but, on the contrary, brings them out with clearness and fulness.

"We have frequently painted samples of clean glass, clean iron, clean tin, and clean dry wood with pure lead and pure zinc mixed with linseed-oil, and after they had become dry, exposed them for months to the elements, and in every case the zinc has shown the greatest durability.

"We believe that if we give zinc a fair chance it will hold its own as material for painting."

The Stresses in Statically Indeterminate Structures. Reprinted from *Indian Engineering*. *The Star Press*: Calcutta, 1892.

When a roof or bridge truss has superfluous members the stresses cannot be determined by the principles of statics, and accordingly some other principle or condition is introduced. In trusses with double or multiple systems of webbing, for example, the assumption is generally made that each system is strained only by the loads which rest upon it. The uncertainty of such a hypothesis is, however, considerable, and this is one reason why these structures have for some years been gradually going out of use. The present tendency in truss design is in the direction of simplicity, single systems being mostly in favor, where the stresses are all determinable by the principles of statics. The pamphlet before us contains applications of the principle of least work to the determination of stresses in superfluous members. About one half of its 24 large pages is a reprint of the paper on that subject by Professor William Cain, which appeared in Transactions of American Society of Civil Engineers in 1891, and the remainder gives examples of the methods of computation as applied to

several large roof trusses and arched bridges. The computations appear quite intricate, and most American engineers would probably prefer to make their designs with fewer unnecessary members. The principle of least work, stated in a general way, is that the work of the forces which resist deformation or deflection is a minimum. This appears now to be a principle well established, and one likely to be of value in future investigations in applied mechanics.

BOOKS RECEIVED.

The Mesabi Iron Range in Minnesota. Extracted from the Twentieth Annual Report Minnesota Geological Survey. Horace V. Winchell, F.G.S.A. A history of the discovery of the ore, and a sketch of the extent of this and other ranges, with the varieties, occurrence, and qualities of the ore, with a short account of the mines already opened.

Bulletin du Société Royale Belge de Géographie. November and December, 1892. The leading article is Christopher Columbus and the Discovery of America, followed by a paper on the Course of the Schelde and the Lys-Durme in the Middle Ages.

TRADE CATALOGUES.

EXAMPLE OF A MODERN BOILER PLANT. *Designed and Constructed for Curtis, Davis & Company, Cambridgeport, Mass.* Westinghouse, Church, Kew & Co., Engineers.

The purpose of this little pamphlet of 10 pages is indicated by its title. The mechanism named above is illustrated by, first, a view of the boiler house, a front elevation of the boiler plant, a plan of the boilers, a transverse section through the boiler and stoker, and another through the economizer. Accompanying these is a very good description of the apparatus. The paper, printing, and typography are of the best.

Illustrated and Descriptive Catalogue of the Harrisburg Ideal Automatic Self-Oiling Engines, Simple and Compound. Manufactured by the Harrisburg Foundry & Machine Works, Harrisburg, Pa.

This is a pamphlet of 32 pages, 7½ × 10 in., elaborately illustrated and beautifully printed on coated paper, in the best style of the printer's art. The first portion of it is devoted to illustrations and descriptions of the "Ideal" simple engine. There are, first, beautiful wood-engravings showing a perspective side and end views, and a longitudinal section showing the internal construction of the engine clearly. These are followed by a transverse section through the crank-shaft, a section of the valve-stem and crosshead, and a side view and plan of the connecting-rod, longitudinal section of crosshead section of cylinder relief-valve, side view longitudinal and transverse section of piston-valve, similar views of the piston, and an end view of the governor. Accompanying these engravings is a very full and clear description of the engine, its construction, operation, and advantages, all models for this kind of literature and authorship.

The second portion of the catalogue is devoted to the "Ideal Tandem Compound Engine," which is illustrated by perspective views of the two sides of the engine and a sectional plan which shows its construction very clearly. The accompanying description is also clear and concise, which is followed by tables giving the sizes, horse-power, etc., of the engines which are manufactured by the firm.

A very good illustration is also given of an "Ideal Cross Compound Engine," and the book concludes with illustrations showing sectional views of the "Weitmyer Patent Boiler Furnace for the Better Combustion of all Fuels, Abatement of Smoke, and Obtaining greater Boiler Efficiency," and a very good perspective view of Harrisburg Double Engine Steam Road-Roller.

Altogether this catalogue may be very highly commended as an example of this kind of literature. Of the engines illustrated we hope to speak more fully in the future.

CURRENT READING.

RECIPROCITY, which has been published in Philadelphia for the last year, has now been issued under the name of *Traffic.* The policy of the paper will remain unchanged, and there will be a vigorous discussion of international questions as heretofore.

NOTES AND NEWS.

New Steamer for the Old Colony Line.—President Choate has asked authority of the Massachusetts Legislature for authority to capitalize the stock of this company at $2,000,000, with a view to building a new steamer to cost $1,250,000.

Chicago Train Service.—The recent tabulation shows that 1,386 trains of all classes arrive and depart daily at Chicago. This traffic is carried on over 41 roads operated by 28 companies. Of these, 28 trains are through expresses and mail trains; 670 suburban and accommodation; 274 merchandise freight trains, and 164 grain, stock and lumber trains. The 28 companies operating these trains own 40,000 miles of railroad.

Jaffa & Jerusalem Railway.—Selah Merrill, United States Consul at Jerusalem, and author of the well-known book "Beyond the Jordan," has written for the March *Scribner* an account of the opening of the Jaffa & Jerusalem Railway in August last, with a description of the origin of the project more than thirty years ago in the brain of an enterprising American, the inventor of a famous pill.

Exhibition Number of "Scribner's."—Charles Scribner's Sons are preparing a novel and interesting contribution to the World's Fair in the form of an "Exhibition number" of *Scribner's Magazine,* to be published simultaneously with the opening of the Exposition at Chicago. It is not proposed that the text shall relate chiefly to the Fair, but, on the contrary, the leading writers and artists have been asked to contribute to the number what they themselves think will best represent them.

Crushed Steel.—A correspondent of the *Indian Engineer* says: "Crushed steel is fast coming into use for cutting stone. It appears to be made by quenching very high carbon steel in cold water, from an excessively high temperature, such as would overheat steel for most purposes. This renders it not only hard, but rather brittle, so that it is possible to pulverize it. It is crushed in a stamp-mill, and sifted closely to size. It is said to be not only cheaper, but much more effective than emery, giving a better polish and quicker, and lasting much longer."

A Bridge at Duluth.—Another bill for the construction of a bridge across the St. Louis River, between the States of Minnesota and Wisconsin, near the village of West Duluth, has been introduced into Congress. The bill provides that the bridge shall be constructed for the passage of railroad trains, and may be used as a wagon bridge, with rates of toll approved by the Secretary of War, or it may be operated without toll or charges, provided an agreement is reached between the municipal government having jurisdiction over the territory and the corporation building it. It provides for a pivot drawbridge over the main channel of the river at an accessible and navigable point.

Books Handled by Machinery.—In the library of Congress, which has over 650,000 bound volumes, the books will hereafter be handled almost entirely by machinery. Orders will be sent to the book-stacks, and books brought from them to the desk for distribution by trays suspended from endless chains, the latter being made to travel by means of an engine in the basement. The mechanism will be noiseless and invisible also, the carriers going beneath the floor of the great central reading-room, to and fro between the librarian's desk and the book-stacks. Every arriving tray will dump itself auto-

matically at the first desk. Likewise, in taking volumes back, each tray will spill its contents, of its own accord, at a certain tier.

Destruction of Valuable Engines.—The Delaware & Hudson Canal Company recently had a fire in its round-house, in which there were three engines; one—the poorest of the lot—was rescued, while the two most valuable were destroyed. This reminder suggests the desirability of constructing round-houses so that, in case of fire, valuable engines may be removed before they are destroyed. Some of the new houses of this kind are constructed with separate stalls placed diagonally, with a separate track arranged for each house and each engine. This permits of the removal of all the engines from the stalls excepting that in which the fire occurs.

A Long Run with Little Oil.—Mr. W. H. Lewis, Master Mechanic of the Chicago, Burlington & Northern Railroad, has been making an experiment to determine as to just how far the cylinders of an engine could be made to run on a pint of oil. The average consumption had been about 65 miles on a pint. He selected an engine that was in good condition and placed a competent engineer in charge, explaining that he wished to demonstrate just how far it is possible to run on a pint. The lubricator was filled and soldered shut. The lubricator held a trifle more than a quart, and when it was emptied the engine had run 1,720 miles, or over 800 miles to the pint. An examination of the valves and cylinders showed them to be in perfect condition.

Consumption of Coal.—*The Coal Trade Journal* gives the following list showing the percentage of coal shipped from the works by rail, consumed at the collieries for steam and other purposes, and locally sold to employés and others residing adjacent to the collieries:

Of the first, or shipments................87½ per cent.
Of the second, or colliery boiler use.....11¼ per cent.
Of the third, or sales locally............ 1¼ per cent.

And this with a large local outside trade.

It has been commonly estimated that 5 per cent. was a fair figure to take for colliery boiler use, while about an equal amount was sold at the collieries. The above figures prove how erroneous the *estimates* heretofore made were when compared with this actual data.

Suppressed Patent Improvements.—A bill has been introduced to prevent the suppression of improvements in inventions. The measure proposes to add a section to the statutes on this subject providing that no patent shall, by reason of a broad or dominating claim or otherwise, prevent the practice or use of any patented actual improvement in the invention forming its subject-matter, provided the patentee or owner of the improvement shall pay a reasonable royalty or tribute to the owner of the patent having the dominating claim, the amount of royalty or tribute to be determined by a court of the United States, the court to take into consideration the profits, past or prospective, to the owner of the improvement and the damages of the dominating patent, similar as in the case of a decree for infringement.

Inter-Continental Railway.—The Inter-Continental Railway Commission has had prepared a facsimile in miniature of Central and South America to show the surveys of the proposed railroad intended to unite the systems of North and South America. The work was done by E. E. Court, of the hydrographic office, and is a faithful representation of the topography of the countries named. It is about 25 ft. long, and will be sent to the World's Fair as a part of the Government exhibit. In addition to the lines surveyed for the railroad the map also shows the routes of the present and prospective steamship lines from North to South America, with the names of their terminal ports and intermediate stopping points, if any.

Honors to Commodore Melville and Constructor Wilson.—The Institution of Naval Architects, of England, has admitted to honorary membership Engineer-in-Chief Melville and Chief Naval Constructor Wilson, in consideration of their services in marine construction and design.

This is the most famous association of its kind in the world; and the distinction is all the greater for the reason that, besides Messrs. Melville and Wilson, there are only three honorary members of the institution. These are gentlemen who have won, in their own countries, a reputation similar to that achieved by Commodore Melville and Constructor Wilson in the United States. Mr. C. A. Griscom, the President of the Inman Line, was admitted as an honorary associate, of which, including Mr. Griscom, there are five.

Coal in Arizona.—Coal is reported near Flagstaff, Ariz. The coal lies in a 6-ft. vein, is free from all objectionable properties, and cokes perfectly. Two companies have been formed to develop the mines, and are making arrangements to work the properties extensively. The coal is found in two localities, 50 and 90 miles, respectively, northeast of Flagstaff. In view of the fact that the Grand Cañon is only 30 miles from these fields, and contains some of the largest and richest copper mines in the continent, the coke produced from these mines is likely to prove a bonanza. The line of the proposed Flagstaff & Grand Cañon Railroad runs very near these fields, which fact is likely to give a new impetus to the building of the road.

New Ships for the International Steamship Company.—This company, which is the successor of the Inman Line, intend to have built at least six steamships in America, all equal at least to the *City of New York* and the *City of Paris*, which was fulfilling their agreement with the United States Government more than the requirements stipulated, these demanding that only two steamships be built here in size and speed equal to the vessels which are to fly the American flag beginning February 22. It is intended to have all the new ships capable even of greater speed than the company's English boats. Some of the new vessels are to be put on the Red Star Line, which the International Company controls, and whose steamships are to stop at Southampton, England, and Boulogne, France, on their way to the terminal port of Antwerp.

Work on the new vessels has already been practically begun by the Cramp Ship-building Company, Philadelphia.

A New Anemometer.—An anemometer which records both wind direction and velocity upon a cylinder by one symbol has been devised by Professor Klossovsky, of the Odessa Observatory. The recording apparatus is moved by clock-work, and the indications are made by electrical contacts. The duration of the contact depends upon the velocity of the wind, a light wind producing a contact of longer duration than a strong one. The indications are by means of arrows printed on the paper covering the cylinder, which show the direction of the wind, and the number of arrows marked on a length of paper corresponding to one hour furnishes data for finding the velocity by an empirical scale determined by comparison with a Robinson anemometer. The apparatus only requires to be adjusted twice a month, or in some instruments only once a month, and calls for no attention in the meantime. One cell is sufficient to produce the contact, for most of the work is done by means of weights.—*Engineer.*

A Great Mississippi River Bridge.—President Harrison has signed a bill which authorizes Chicago men to construct over the Mississippi River at New Orleans the largest cantilever bridge in America. Surveyors and engineers will soon begin preliminary operations, and within three years the $5,000,000 structure will be opened for traffic. The plan is one in which all the railroads in the South are interested, and the contract has been given to Corthell & Kerner, civil engineers of this city. The bridge must be built of steel with two piers in the river. The length of the main channel span will be 1,095 ft. and the two side spans 757 ft., with the lowest part of the superstructure not less than 85 ft. above the extreme high-water mark. The charter granted by Congress provides that one approach, if practicable, shall be within the city limits of New Orleans. The place now practically selected for it, however, is at Nine Mile Point, and not far from Carrollton.

A Long Trolley Road in Pennsylvania.—A charter has been granted in Pennsylvania for a trolley line of railroad 80 miles long. The road is called the Northumberland, Bloomsburg & Scranton Street Railroad Company, and connects 39 towns in that region. Among them are Lackawanna, Pittston, Catawissa, Mechanicsville and Nanticoke. It is a very busy center, and the establishment of a trolley line would materially interfere with the local traffic of the steam roads. At the office of the Reading Railroad Company it was stated that these roads were generally given the privilege to run over the turnpikes and township roads, thus saving the expense of grading, the largest item of the steam roads' expense in a mountainous country. It was acknowledged that it would make a difference in the revenues of the companies with which such road came in competition. The capital of the new road is $500,000, and it is said that a syndicate in Philadelphia is furnishing the money.

For the Pennsylvania Railroad Company.—This company, it is said, has recently bought the southern half of the block bounded by 38th and 39th streets and 11th Avenue and the Hudson River. About five years ago the same company

purchased all the adjoining block between 37th and 38th Streets and 11th Avenue and the Hudson River, except so much as extended for 100 ft. west of the avenue front. It would thus appear that the Pennsylvania Railroad Company had entered upon a policy of acquiring large slices of land in this city.

What it means to do with this ground has been matter of speculation in railroad circles. That it will be made contributory to its terminal facilities in this city is evident; but how it will be built up, if at all, is the interesting question. It is said by one of its representatives in New York that if the company had bought it they would use it merely for tracks, just as they were using the ground in the next block, and would not build it up at all, much less in a "mammoth" or costly manner.

The Morgan Line's New Steamer, "El Rio."—This vessel, built after designs of Mr. Horace See, reached New York recently, on her maiden voyage, direct from the yards of the Newport News Ship-building Company, where she was launched November 26. She will proceed, about the middle of next week, to take on board freight for New Orleans.

The new ship has a length over all of 406 ft., a beam of 48 ft., and a depth from the top of the keel to the under side of the upper deck of 33.9 ft. Her tonnage displacement measures 4,500 tons.

She is designed for a 16-knot speed per hour. Her motive power consists of a vertical, inverted, triple-expansion engine, having cylinders measuring, respectively, for high, intermediate and low pressures, 32, 52 and 84 in. The stroke is 54 in. The working steam pressure will be 167 lbs. Steam will be generated by three double-ended Scotch boilers, having three furnaces at each end. Each furnace is of the corrugated type. In rig, *El Rio* is provided with two masts. A sister of *El Rio*, named *El Cid*, is now on the stocks at the Newport News yards. *El Cid* is to be a steel ship, and in general dimensions and internal arrangements a duplicate throughout of *El Rio*. The new ships will be used solely as freight steamers.—*New York Times.*

Economy of Gas-Engines.—An electrical paper says that "the waste involved by the intervention of the steam-engine, with the clumsy modes of raising steam and the clumsier ways of utilizing it, are apparent to any one who looks into the calorific value of fuel." That is a sort of preface to the statement that gas-engines are "beating the steam-engine, both in fuel consumption and in general economy." Then it proceeds, "It is to be hoped that some central stations in this country may be induced, at all events, to try a supplementary gas plant or two for day loads or for emergency use." If the gas-engine is so very economical, why use it merely for emergency purposes? The position of the gas-engine is well understood, and users of steam are quite aware that they do not get the full value of the fuel; but no "electrician" has yet attempted to improve on the "clumsy methods of raising steam" except the man who was going to use electricity to raise the steam that produced the electricity. He is still "going to."—*English Mechanic.*

Bi-metallic Wire.—Herr Elsässer recently remarked before the Electrotechnischer Verein, of Berlin, that besides the bronze wire already used in telephone installations, and which during the past year has also come into favor for telegraph service, several other kinds of wire have been employed experimentally, among them the so-called compound wire, consisting of a cast-steel core and an outside layer of copper. This wire, it is said, has proved very satisfactory, and has specially commended itself for service along the sea-coasts, where there is much exposure to fog and dampness generally. It is reported to have been found that in this wire the copper exterior adheres perfectly to the steel body, and does not tend to peel off even after bending the wire a number of times. One of the other kinds of wire under trial consisted of an aluminium-bronze core with a copper-bronze envelope. This wire, which is said to be of great tensile strength, and to have a comparatively low electrical resistance, is considered specially adapted to take the place of the plain bronze wire already in use.

Readjusting a Misfit Jacket.—It is understood that the attempt to place the "misfit jacket" of the big gun at the ordnance yard recently was a failure. After two heatings the jacket was moved only four inches, leaving it eight inches out of place. After the tremendous heating to which the end of the tube and its jacket was subjected to in the effort, there are grave doubts whether the gun can ever be relied upon, even if the efforts to force the jacket into place shall be finally successful, for the condition of the steel must have undergone a radical alteration in molecular structure, so that its strength and all the other characteristics as gun metal must be a matter of surmise alone. A beautiful experiment was made a few years since at Fried Krupp's famous gun factory at Essen, whereby a completely finished gun of considerable caliber was "disassembled" by the employment of a spray of liquefied carbonic acid gas. The inner tube was sprayed with this intensely cold fluid, with the result that the contraction was sufficient to permit of the jackets and other portions of the gun to be removed without injury to either temper or mechanical fit.

An Atlantic Derelict.—There is a vessel drifting about the Atlantic with a cargo valued at $20,000, and a most remarkable circumstance in connection with the craft is that it has been drifting about for nearly two years, and has traveled a distance of 5,000 miles. The vessel is the *Wyer G. Sargent*, and she started on her voyage from Laguna with a cargo of Mexican mahogany in the month of March, 1891. She got dismasted in a hurricane, and her crew were saved by a Norwegian vessel. The *Wyer G. Sargent* is a vessel of 1,500 tons register, and since her abandonment she has been passed twenty-seven times by various ships. The last time she was sighted was on October 12 by the steamer *Asiatic Prince*, about 900 miles from Bermuda. Her decks were then awash, but the bow was well out of the water, and it is said that there was little or no alteration in her condition since the time she was abandoned until she was last seen. She showed no signs of breaking up, and it is probable that she will drift about for a long time yet, unless she is cast somewhere ashore. The *Wyer G. Sargent* has twice crossed the Gulf Stream in her derelict state, and was known to be at one time within 250 miles of Bermuda, and at another 600 miles from the Azores.

Weight of a Crowd.—In a paper by Professor Kernot, read before the Victorian Institute, he compared the various estimates as to the weight per square foot of a crowd. One estimate, quoted as French practice by Stoney and Trautwine, gives 41 lbs. per square foot as the weight of a crowd. Hatfield, in "Transverse Strains," gives 70 lbs.; Mr. Page, engineer to Chelsea Bridge, 84 lbs; Mr. Nash, architect to Buckingham Palace, quoted by Tredgold, 120 lbs.; Mr. W. N. Kernot, at Working Men's College, Melbourne, gives the weight as 126 lbs.; Professor W. C. Kernot, at Melbourne University, puts it at 143.1 lbs; and Mr. Bindon B. Stoney, in his work on "Stresses," as 147.4 lbs. per square foot. The space occupied by soldiers, as taken by Hatfield in his estimate, is not the same as a crowd. Soldiers are arranged in lines at a distance apart to allow room for knapsacks and other accouterments; but a crowd is forced together into close contact, an average man in a crowd occupying a space of little if any more than 1 sq. ft. On the whole, Professor Kernot inclines to favor Mr. Stoney's estimate of a little more than one man per square foot, and gives it as proved that a dense crowd of well-grown men weighs between 140 lbs. and 150 lbs. to the square foot.

Coal Supply of Europe.—A pamphlet in relation to the coal supply of Germany and other nations has just been published in Berlin by the Minister of Commerce, and contains some interesting figures. The coal supply of Germany in the districts of the Ruhr, the Saar, Aix la Chapelle, Upper and Lower Silesia and Saxony is estimated at 112 milliards of tons. At the present rate of consumption, it is declared, no want of coal would be felt in the poorest coal beds for 250, or in the richest ones in Westphalia for 1,000 years. Twenty years ago the coal supply of Great Britain was reckoned at 198 milliards of tons. Estimating the supply of France at approximately 18, of Austria-Hungary at 17 and of Belgium at 15 milliards of tons, the Central European States are held to possess a coal supply of 360 milliards of tons. The writer comes to the conclusion that a want of coal will make itself felt first in Austria, France and Belgium, then in England, and last of all in Germany. The average consumption of coal in Germany per head of the population only amounted in 1890 to 1.66 tons, whereas in England it was 4.81 tons. The author does not introduce into his comparisons either the coal supply of Russia or that of America, as he is of opinion that the coal of those countries will never be of importance to the States of Central Europe.

The "American Line" of Steamers.—With the opening of the new American Line service between New York and Southampton in February, the favorite steamships *City of New York* and *City of Paris* will be transferred to the American flag in accordance with the act of Congress, and the old trade name of Inman Line will be dropped for this express service. The words "City of" will also be dropped from the name of

the steamships, and thereafter they will be known as the *New York*, *Paris*, *Berlin*, and *Chester*.

The two new steamships being built for the coming successors of the Inman Line will be twin-screw steamships of somewhat larger tonnage than the *New York* and *Paris*. The engines will be of the latest type, and the steamers will make a speed of 20 knots, as required by the contract with the United States Government for carrying the mails. They will, of course, be under the American flag, and will be built so as to be readily convertible into Government cruisers and capable of carrying the armament required by the law. Their speed and very great coal endurance will make them an invaluable auxiliary to the national navy, and without any further cost to the Government than the moderate pay allowed for carrying the mails. These ships are already under contract with the William Cramp & Sons' Ship & Engine Building Company, and plans are nearly completed for three more.

A Fast Boat.—C. D. Mosher, the designer of the fast craft *Norwood*, is now completing a 78-ft. boat, with 9 ft. 6 in. beam. The engine is of the quadruple compound type with cylinders in a straight line, supported over an elliptical base of cast and wrought iron by means of slender and steel vertical pillars, each pair of which are braced with straining rods in the form of an X, split down through the point of crossing and provided with a screw by which the braces can be strained until all racking is obviated. The stroke of the engine is 10 in., and the cylinders are respectively 9½, 13½, 18, and 24 in. in diameter. Every ounce of superfluous metal has been removed from the castings forming the cylinders. It is estimated that the complete engine will weigh less than 3,600 lbs., and that at a speed of 500 to 600 revolutions it will develop from 500 to 600 H.P., with a steam pressure of 250 lbs. To secure the minimum of weight with the maximum of strength, all of the working parts have been reduced to the smallest practical dimensions, or else relieved of superfluous metal at the center by boring. The rock-shafts have 1-in. holes through them. The piston and connecting-rods are hollow, and the big crank-shaft has been bored out whenever a tool could be used upon it. This shaft was carved out of solid steel forging weighing 2,012 lbs. It now weighs 414 lbs. The engine when set up will occupy less than 14 sq. ft. of floor space. Steam will be furnished by a pipe boiler of peculiar construction, and is built with a view of standing great pressure, occupying little space, and steaming rapidly.—*American Shipbuilder.*

Properties of Matter at very Low Temperatures.—Professor Dewar recently lectured in the Royal Institution in London upon the results of some of his investigations of the properties of matter at very low temperature. Liquid oxygen, until recently, was only produced in very small quantities, but Professor Dewar produces it by the pint, and is able to demonstrate its beautiful blue color, its magnetic quality, and its characteristic spectrum. As oxygen boils at 182° below zero, the preservation of it in a liquid condition for any time has been practically impossible, but the problem has been solved by the discovery that evaporation can be checked by surrounding the vessel containing the oxygen by a very high vacuum. The London *Times*, in its report of the lecture referred to, says: "Many remarkable phenomena were shown, but none was more worthy of attention than the little bulb of liquid oxygen, something between a walnut and a golf-ball, which hung in a clip upon the lecture table. It was filled and hung up at an early period of the lecture, and it remained four-fifths full at the close. If a conjurer had made his appearance with a large vessel of boiling water and a brisk fire beneath, and if in that water he had boiled for half an hour a piece of ice as big as a golf-ball without reducing it by more than one-fifth, every one would have been vastly astonished. But the little bulb full of liquid oxygen was far more wonderful. The difference of temperature between the conjurer's ice and his boiling water is 100° centigrade. The difference between the temperature of Professor Dewar's bulb and the air of the theater was not less than 210° centigrade. Yet, though that scorching blast necessarily had free access to the oxygen in one direction, the liquid was so perfectly protected by its vacuum jacket as to attain that relatively high degree of permanence."

The Deduction of a Right Line.—*The Worcester* (Mass.) *Spy* says: "G. Vailati, Professor of Mathematics in the University of Turin, Italy, has sent to Clark University an article just published by himself giving an elaborate geometrical formula for the deduction of a right line. He had just received from B. I. Gilman of the university a copy of an article printed by him at the same time and treating the same question, although from a psychological standpoint. The remarkable thing is that these two investigators—one in Worcester, one in Turin; one from the psychological, and the other from the mathematical standpoint—should have reached, independently of each other, not only the same general conclusion, but the same set of mathematical formulæ for expressing that conclusion. This is a striking illustration of a number of things—viz., of the close interdependence of very distinct departments of research, of the accuracy of method which reaches identical results from such different data, and of the fact that discoveries come when and where the time is ripe for them."

[Will not some of our readers who are well up in mathematics explain to those who are not what "the deduction of a straight line means"? We have known people who could not "deduce" a straight line, but they were generally intoxicated. We have also known a man who could not understand mathematics, because "the axioms were not self-evident" to him. He was not convinced, he said, that the shortest distance between two points was a straight line. He thought it was quite possible that some kind of a crooked line might exist which would be shorter than a straight one. This man was not intoxicated either. The "psychological deduction of a straight line" we are quite sure must be an intensely interesting subject.—EDITOR AMERICAN ENGINEER.]

Trial of Harvey Steel Armor-plate.—A few weeks ago a Harvey nickel steel armor-plate, 6 in. thick, was tested on board the *Nettle* at Portsmouth. The 6-in. breech-loading gun was used, firing Holtzer's forged steel projectiles weighing 100 lbs. each. The trial was of a very unusual kind, the gun and projectile being those regularly employed for testing 10½-in. plates, except, indeed, that for two out of the five rounds constituting the usual test Palliser chilled iron shot are used, whereas in this case four rounds were fired with Holtzer projectiles. It was out of the question to attack this plate with the usual charge and striking velocity, and the following order was observed: Round 1 was fired with a charge, we believe, of 30 lbs.; at all events, the striking velocity was 1,507 ft. per second. The projectile was pulverized without cracking or seriously injuring the plate. Round No. 2 was fired with, we believe, 42 lbs. of powder. The striking velocity was 1,813 ft. per second. The shot was again broken up, but the plate was cracked. No. 3 round was fired, we believe, with 48 lbs. of powder. The striking velocity was 1,960 ft. per second. The projectile perforated the plate and was lodged in the form of fragments in the backing. No. 4 round was fired with the charge again reduced, so as to give a striking velocity of 1,815 ft. per second. The shell was again broken up without perforation, and no further cracks were made, and no part of the plate fell off from the backing.

This is a most remarkable trial, for it must be borne in mind that the resisting power of a plate is more nearly as the square of its thickness than as the first power, so that for a 6-in. plate to break up a projectile which until recently was a match for 10½ in. is a great triumph, and it may be seen from the account that any structure behind the backing would have been protected. Attention must be called to the fact that while the shot was broken up at 1,815 ft. velocity in such a way that a great part of its striking energy must have fallen harmlessly on the plate, it cannot be argued, on the other hand, that a shot is only capable of delivering a fixed quantity of energy before facture, and that all energy over and above that is lost, for it appears that at 1,960 ft. velocity much more injury was done, because we suppose more energy was delivered before the work of fracture was complete. Probably the fracture of the projectile occupies such a period of time that more work is done on the plate by increasing the velocity, because although the shot is the weakest element, there is not time to find the line of least resistance before additional injury is done to the plate. It is perhaps the same action as causes fulminate not to follow the lines of least resistance taken by slower powder in bursting a vessel.—*The Engineer.*

Bacterial Purification by Light.—The bacterial purification which takes place in a river during its flow has been recently attributed in part to the process of sedimentation which the micro-organisms in the water undergo, but it would seem that yet another factor must be taken into account. Buchner, in some investigations which he has recently published, shows that this diminution of the numbers present may be also assisted by the deleterious action which light exercises upon certain micro-organisms. A systematic series of experiments was made by introducing typhoid bacilli, Koch's cholera spirilla, also various putrefactive bacteria, into vessels containing sterilized and non-sterilized ordinary drinking water. As a control, in each experiment one vessel thus infected was exposed to light, while a second was kept under precisely similar conditions, with the exception of its being covered up

with black paper, by means of which every particle of light was excluded. The uniform result obtained in all these experiments was that light exercised a most powerful bactericidal action upon the bacteria in the water under observation. For example, in one water in which at the commencement of the experiment 100,000 germs of typhoid bacteria were present in a cub. cm., after one hour's exposure to direct sunlight *none* were discoverable, while in the darkened control flask during the same period a slight increase in the numbers present had taken place. Even the addition of culture fluid to the flasks exposed to sunlight could not impair in the least the bactericidal properties of the sun's rays. In the flasks exposed to diffused daylight the action was less violent, but still a marked diminution was observed. In his later experiments Buchner has employed agar-agar, mixing a large quantity of particular organisms, pathogenic and others, with this material in shallow covered dishes and then exposing them to the action of light and noting its effect upon the devlopment of the colonies. For this purpose strips of black eaper cut in any shape (in the particular dish photographed py Buchner, letters were used) were attached outside to the bottom of the dish, which was then turned upward and exposed to direct sunlight for one to one and a half hours and to diffused daylight for five hours. After this the dish was incubated in a dark cupboard. At the end of 24 hours the form of the letters fastened to the bottom of the dish was sharply defined, the development of the colonies having *taken place in no part of the dish, except in those portions covered by the black letters.* Some interesting experiments on the same subject have also recently been made by Kotljar. In the course of these investigations the author found that of the colored rays of the spectrum the red favored the growth of those bacteria experimented with, while the violet rays acted prejudicially, although less so than the white rays.

COMPOUND EXPRESS LOCOMOTIVE FOR THE NORTHERN RAILWAY OF FRANCE.

ON the opposite page we illustrate a new compound express locomotive which has been built for the heavy express traffic of the Northern Railway of France. The engine is a development of another compound express engine built in 1886, and which, in spite of some minor defects, has given, on the whole, very favorable results in the matter of economy of running expenses and maintenance. The new engine has been constructed by the Société Alsacienne de Constructions Mécaniques, Belfort, to the designs of M. Du Bosquet, Locomotive Superintendent of the line. The engine is four-coupled, and has four cylinders, namely, two high-pressure and two low-pressure cylinders, the former being 13.4 in. in diameter, and the latter 29 in., with a stroke in each case of 25.2 in. In our next issue we shall publish further details of this engine, and defer our description until then. We are indebted to *Engineering* for the engraving.

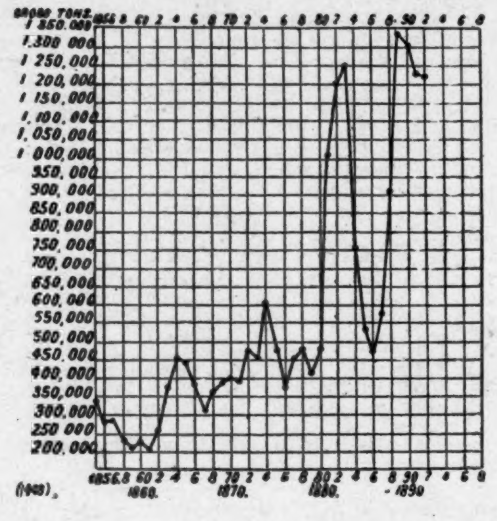
FOREIGN MARINE NOTES.

A New Armored Coast-Defense Ship—the *Admiral Oushakoff*—is being built for the Russian Navy. This vessel is of the monitor type, with low freeboard and two turrets, each carrying two heavy guns. She will draw about 14 ft. of water on 4,150 tons displacement, and has twin screws with engines of 4,500 H. P. In addition to the turrets there is a barbette in which several rapid-fire guns will be carried.

The latest addition to the Italian Navy is the *Marco Polo*, second-class ironclad, recently launched at Castellamare She belongs to the class of torpedo-rams, but is larger than those already existing in the Italian Navy. Her principal armament will be six 6-in. cannon, four of which will be under deck, while the other two will be placed in turrets at the prow and stern of the vessel, and ten other cannon of 4.7-in. bore within decks. There will be four torpedo-tubes above water on the battery, and one under-water tube at the prow. There will be other minor artillery, and a powerful ram below the surface of the water. The *Marco Polo* is 330 ft. long and 4,460 tons displacement; she has two screws, each driven by a compound engine.

Leaky Tubes.—Hiram S. Maxim says of leaky tubes: "In experiments which I have been conducting during the last two years, I find that where the fire is very hot and the heating surface very great in proportion to the water, a forced circulation is a *sine quâ non*, and this is very easily accomplished without the aid of any other machinery than that already employed on shipboard. Suppose that the boiler pressure should be 150 lbs. to the square inch; I should then have the pressure of my feed-water 200 lbs. to the square inch, and should have it escape from the feed-pipe into the boiler through a small orifice, which may be automatic, and which will maintain a constant difference of pressure of 50 lbs. to the square inch between the water in the feed-pipe and in the boiler. This will give a solid stream of dense water escaping through an orifice with a force of 50 lbs. to the square inch, and this can be made to operate on ten times its volume of the surrounding water in the boiler after the manner of an injector.

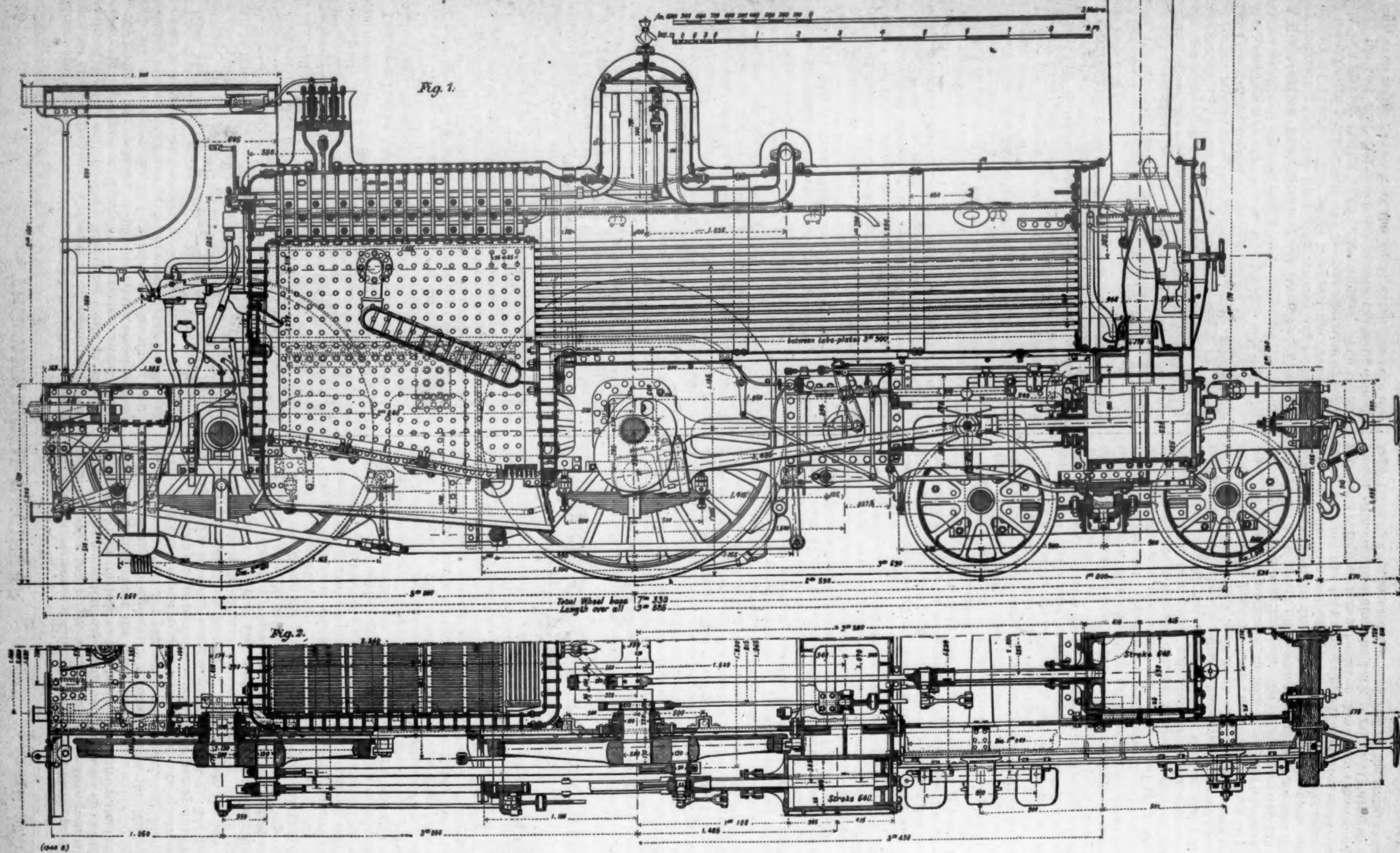
Ship-building in the United Kingdom.—The accompanying diagram, copied from *Engineering*, was prepared by Mr. William Cooper, Steamship Surveyor Newcastle-on-Tyne, shows the gross tonnage of all vessels built in private yards in the United Kingdom, including war-ships and foreign-owned craft, from 1855 to 1892 inclusive. The alternations between times of severe depression and great activity are well illustrated.



The "Lucania."—The new steamer of the Cunard Line was launched on February 2, at the yard of the Fairfield Company, Govan, near Glasgow. She is a sister ship of the *Campania*, built for the Cunard Company at the same yard. The dimensions are: Length over all, 625 ft.; breadth, 65 ft.; depth, 41 ft., and nearly 13,000 tons in measurement. The *Lucania* is 20 ft. longer and 7 ft. broader than the *Teutonic* or *Majestic*, and is intended to accommodate 450 first cabin, 250 second cabin, and 600 steerage passengers. It is expected that the *Lucania* and *Campania* will lower the ocean record.

Fast Atlantic Line for Canada.—There is some talk in Canada of a fast Atlantic service between Montreal and Great Britain, but it is not at all probable that the scheme will be carried out. At present the service between the two countries is such that the freight rates and ordinary passenger service is satisfactory, and there is not a demand for quick travel sufficient to warrant the construction of record breakers and the granting of a government subsidy, which would be necessary in order to keep the line alive. The Government has not as yet, however, committed itself in the slightest degree either for or against the project.

Fast Torpedo Boats.—The famous torpedo-boat builder at Elbing, Schichau, has just attained an unprecedented speed even for this class of vessel—torpedo boats built by him for the Russian and Italian governments having reached 27½ knots on an hour's run at sea. The new British boats are to be 200 tons displacement, while the Russian boats are 130 tons, so that the former may do better by reason of greater power and greater size. The length of Schichau's boat is 152 ft. 6 in., the beam 17 ft. 5 in. She may carry 40 tons of coal in her bunkers. On trial, however, she had only 20 tons on board. The small guns carried weighed 2½ tons; the torpedo armament, 6 tons; the crew, provisions, stores and firearms, 4½ tons; drinking water, 2½ tons; engine and boatswain's stores and reserve parts, 4½ tons; so that all the movable parts come to 20 tons, making, with coal, 40 tons. The vessel and the ma-



COMPOUND EXPRESS LOCOMOTIVE FOR THE NORTHERN RAILWAY OF FRANCE.

chinery are, therefore, very light. The shell plates are barely a quarter of an inch thick. There are two locomotive boilers, protected by the coal bunkers, supplying steam at 195 lbs. pressure to high-speed engines. The guaranteed speed was to be 26½ knots in the open sea, while on trial the vessel actually made 27½, or, to be precise, 27.4 knots, as a mean of one hour's steaming at sea. Schichau promises even higher results with torpedo boats he is now completing.—*Steamship*.

New Shaft for the "Umbria."—Messrs. Vickers' Sons & Company, River Don Works, Sheffield, have been instructed by the Cunard Steamship Company to make a new thrust shaft to replace the one recently broken on board the *Umbria*. The ingot from which the shaft was forged under the press weighed 55 tons. Exclusive of the collars, which have each a diameter of over 3 ft., the shaft is to have a diameter of 25 in., with a length of 20 ft. The old shaft, which was also produced at the River Don Works, was made in 1884, and has consequently done duty for eight years. The new shaft is about ready for delivery. Messrs. Vickers are now engaged upon an order for five 68-ton guns for the British Government.

The new Italian battle-ship which is building at Venice, and has been named *Ammiraglio di Saint Bon*, in recognition of the great services of the late Minister of Marine, is of a new type, and will have a displacement of 9,800 tons, a length of 344 ft. 6 in., a beam of 69 ft. 3 in., and an extreme draft of 24 ft. 8 in. With forced draft she will develop 13,500 H.P., and steam at 18 knots speed; with natural draft a speed of 16 knots will be obtained, with an expenditure of about 9,000 H.P. There is an over-all protective deck of steel, varying in thickness from 1½ in. to a little over 3 in. An armored citadel, in the middle of the vessel, and the armored belt will carry plates varying from 4 in. to 9¾ in. thick. At each end of the citadel will be a turret armed with two 9.9 in. guns. Elsewhere, with suitable shields, will be mounted eight 5.9 in., eight 4.7 in., four 2.2 in. 6-pdrs., and 12 small quick-firing or machine guns. The coal-carrying capacity is to be 1,000 tons. It was originally proposed to call this ship *Christoforo Colombo*, a name which has been given to an unarmored cruiser. Two similar vessels are ordered to be built, one at Spezia and the other at Castellamare. Each will have twin screws, triple-expansion engines, 12 boilers, traverse armored bulkheads, double bottoms throughout, a great number of water-tight compartments, and, in fact, every modern improvement. The definite abandonment of the over-large gun by the Italian Navy, which, for the *Duilio*, launched in 1876, was the first to adopt it, is noteworthy. No Italian ironclad built since 1885 carries a gun of greater weight than 68 tons.—*Engineer*.

Broke her Shaft.—The Dutch steamer *Schiedam*, from Rotterdam for New York and Baltimore, recently broke her shaft at sea.

At six o'clock on the morning of January 28 all hands on board were startled by a tremendous crash, and it was at once surmised by those about deck that the shaft had broken. When the crash occurred the vessel shivered from stem to stern, and no one on board doubted that the propeller had struck something, and that this caused the breaking of the shaft.

The engineers worked four days in making repairs to the shaft, and finally so patched it up that the steamer was able to proceed under steam at the rate of seven or eight miles an hour, but there was always great danger of the shaft giving out again.

During the four days the repairing was being done a hurricane prevailed, and at times the steamer was unmanageable, her spread of canvas not being sufficiently large to enable her to be handled. The hurricane was so severe that she could not spread all her sails, for had she done so they would have been blown to pieces.

After steaming for thirty-six hours after the repairs had been made, the fastenings parted, and the *Schiedam* was again helpless. The engineers worked steadily for twelve hours in patching up the break, and then the engines were started. The shaft had made but comparatively few revolutions when it again parted. This time it so badly damaged one of the trusses that further repairs were impossible. All the sail possible was set and the steamer turned about to make for Queenstown.

Her condition was reported in Queenstown, and tugs were sent out and towed her into that port.

A Combination Tank Steamer.—A steamer of a new and very interesting type has been built recently for Samuels & Company, of London. The vessel is named the *Murex*, and has been constructed especially for the transportation of petroleum, in a manner similar to all tank steamers. The novelty lies in the fact that the vessel can receive the most delicate goods, even cereals, as soon as the liquid cargo has been discharged. It measures about 350 ft. in length, and is provided with 10 tanks, five on each side, and these two groups are separated by a longitudinal partition formed by an extension of the keel into the hold. The tanks extend from the bottom of the hold up to about the water line.

This special construction is separated from the forecastle, where the quarters for the crew are located, and from the stern, where the machinery, boilers, and officers' quarters are placed, by two strong partitions about three feet apart at each end, the space between being kept full of water. The result is that the oil tanks are thoroughly isolated from the bow and stern quarters of the ship.

Openings on the port and starboard permit the steamer to be rapidly loaded to the hatches with mineral oil, and a powerful pump insures the rapid delivery of the 2,500 tons of oil which the *Murex* can carry. This last operation can be accomplished in 24 hours.

The question now arises as to how these tanks can be cleaned, impregnated as they are with oil, and how they are to be made fit to receive a cargo of another character. A very powerful blower sends a great volume of air in a rapid current into the tanks, which are put in communication with each other by openings in the partition walls, made for the purpose. This thoroughly dries the walls, and their disinfection is afterward assured by the introduction of a vapor especially prepared for the purpose, whose composition is kept secret and which absolutely removes every trace and odor of the liquid.

The innovation is a valuable one, for by it the *Murex* can always take on a return cargo from the port to which it may have carried one of petroleum. For example, she recently carried a cargo of oil to India and returned with one of rice.

AMERICAN AND ENGLISH LOCOMOTIVES.

The two folded plates with this number of the Journal show respectively the system of framing for the two locomotives which are the subjects of this series of articles. They represent, too, distinguishing features of English and American practice. The plate frame is, we believe, universally used on English locomotives, and is not used at all in this country; and the reverse is true of the "bar" frame. There has been a great deal of discussion of the practice in the two countries—or, perhaps, if we said *vituperation* it would describe better what has been written and said about it.

It has been argued, in favor of plate frames, that they are stiffer vertically and more flexible laterally than bar frames, which is no doubt true. They also have the advantage that they permit of a wider fire-box being placed between them. It will be seen that the outside width of Mr. Adams' fire-box is 46½ in., whereas the fire-boxes of American locomotives, when placed *between* the frames, are not more than from 42 in. to 43 in. wide. This argument has no force, however, when the fire-box is placed entirely above the frames—as in Mr. Buchanan's engine—which is now a very common practice in this country. It may be urged as an objection to this that it requires the boiler to be placed very high, and the fire-box cannot, under these conditions, be as deep as it is when it is placed between the frames.

It has also been said of plate frames that there is less machine work required on them, and consequently they cost less. The evidence with reference to this point is not conclusive, however, and will be referred to further on.

In favor of bar frames it is said (1) that they do not obstruct the view of and access to the internal parts of an engine as much as plate frames do; (2) that no deficiency in their vertical strength has ever been experienced; (3) that solid bars have much greater capacity for resisting an endwise concussion, and, therefore, they will resist collisions better than plate frames; (4) that after being planed and machined over their whole surface, they are easier fitted to an engine than plates are which have not true surfaces; (5) bar frames being made in two parts, which are fastened together to to the other parts of the engine by bolts, they are easier to remove and repair or replace than a plate frame like that shown in the engraving, which is rivetted. In case of a front collision, which would bend or break the front end of a plate frame, it would be necessary to take down the whole of the one frame which was injured. To do this the rivets in the stay plates must be cut off, which takes much time and labor, whereas an American frame, being fastened by bolts alone, they or their nuts can easily be unscrewed without injury to them, and they can be used again. If the front end only of the frame is injured it can be taken down and repaired or replaced without disturbing the back portion. Conversely the same thing is true in case the back end of the frame is dam-

aged and the front end uninjured. We are speaking, perhaps, without adequate knowledge in saying that it seems doubtful whether, if a plate frame on one side was damaged to such an extent as to require renewal, a new plate could be fitted in place of the injured one without taking down the uninjured one on the opposite side. With American frames one side can easily be replaced without disturbing the other.

Regarding the relative amount of machine work on the two kinds of frames, it may be said that the engravings of the English frame show that the axle-box guides are bolted to the frames. As stated in Mr. Adams' specifications, "the stay-plates are to be planed to the exact width required, and securely *rivetted* to the frames by cold rivets." This method of construction requires a large number of bolts and rivets in the frames. The drawing of those for the English engine shows that there are no less than 666 holes in the two frames and in the front and tail braces or stay-plates. Each of these holes, with a very few exceptions, must have a bolt or rivet fitted into it. A pair of American frames with the front and tail braces has only 184 holes; so that the number of bolts and rivets to be fitted in the two kinds of frames is in proportion to the number of holes. At present we have not the requisite data to be able to compare the relative cost of drilling or punching the holes and fitting bolts and rivets to them with that of planing and slotting American frames.

The following are the builders' specifications for the frames of the English and American locomotives:

SPECIFICATIONS FOR FRAMES FOR AN ENGLISH EXPRESS PASSENGER LOCOMOTIVE FOR THE LONDON & SOUTHWESTERN RAILWAY.

The frames and frame stay-plates to be made of the best mild Bessemer or Siemens-Martin steel, supplied by makers approved by the Railway Company's Locomotive Superintendent, and of the exact dimensions, both as regards form and thickness, as given on the drawings.

Quality.—The quality of the material to be that generally known as mild-steel plate, and to be free from silicon, sulphur, or phosphorus. The ultimate tensile strain that the plates will stand to be not less than 24 nor more than 30 tons per square inch, with an extension of not less than 23 per cent. in 10 in.

Manufacture.—All plates, whether made by the Bessemer or Siemens-Martin process, to be made in the most approved manner from ingots hammered on all sides, and when reheated to be rolled truly to a uniform thickness. Both sides to be perfectly clean and free from pitting, roll marks, scale, dirt, overlapping, or other defects. Each plate to be taken from the rolls at a full red heat and allowed to cool gradually on a flat surface. Each plate is to be sheared to the dimensions given, and in no case to be sent out before being levelled sufficiently true for machining. All plates that are wavy or buckled or in any way defective will be rejected, and must be replaced by the makers, free of cost. The maker's name and date of manufacture must be legibly stamped on every plate, and not nearer the edges than 9 in.

A sample or test plate at least two feet square must be sent in by the maker as a sample of what will be supplied in the plates to be made under this contract, together with a complete analysis of the same. This test plate is to be ½ in. in thickness, and from it pieces will be taken for proving in the following manner:

Test.—A piece 6 in. long will be bent over cold until the ends meet each other closely, and no fracture or sign of failure is to be observable in the heel of the bend. Pieces 3 in. wide will also be taken and a ⅝-in. hole punched through same, which shall stand being drifted cold by taper drifts until it reaches 1½ in. in diameter without the edges fraying or showing signs of fracture.

Samples or shearings from the plates must be tested in the presence of the Railway Company's Locomotive Superintendent or his Inspector, on the premises of the maker whenever desired.

All the plates are to be perfectly level and straight throughout and marked from one template. All holes are to be drilled and rimered out to the exact sizes given, and each bolt and rivet must be turned to gauge, and fitted into its place, a good driving fit. When the frames and cylinders are bolted together, and before the boiler, wheels and axles are put in their places, the accuracy of the work must be tested by diagonal, transverse and longitudinal measurement.

The frames are to be placed at a distance of 3 ft. 11½ in. apart, and to be stayed at the leading end, in front of the driving-wheels and in front of the fire-box, by steel plates and angle irons, and by a cast-iron foot-plate at the trailing end; the steel plate stays to be planed to the exact width required and securely riveted to the frames by cold rivets. At the leading end a steel casting with suitable flanges is to be riveted to the frames at bottom with ⅞-in. rivets pitched zig-zag, and this casting is to be provided with a boss for carrying the bogie center-pin. This boss to be accurately turned, and to be planed on the bottom side to suit the bogie cross-slide. This casting must be perfectly square with the frames. The driving-wheels are to be placed 1 ft. 5 in. in front of the fire-box. The driving and trailing axle-box guides to be provided with adjustable wedges having a taper of 1 in 10, as shown, guide and wedge to be of the very best cast steel, supplied by makers to be approved by the Railway Company's Locomotive Superintendent. The top and sides are to be in one piece, free from honeycomb and all other defects, and the flanges are to be planed all over and fitted to template; they are to be fastened to the frame with bolts 1 in. in diameter, accurately turned and driven tight in the holes. The horn-stays are to be attached to the guides as shown on drawing. The frames must be finished with a good smooth surface 1 in. thick, and the axle-box guides must be free from cross-winding and square with the engine in all directions. The rubbing plate on back end of frame for the intermediate buffer is to be of wrought iron case hardened.

SPECIFICATIONS FOR FRAMES FOR AN AMERICAN EXPRESS PASSENGER LOCOMOTIVE BUILT BY THE SCHENECTADY LOCOMOTIVE WORKS.

Of best hammered iron, main frame in one section, with braces welded in. Forward section securely bolted and keyed to the main frame. Pedestals protected from wear by cast-iron shoes and wedges, and locked together at bottom by a bolt through cast-iron thimbles. Width of frame, 4 in.

Whatever may be thought of the frames of the two engines, it must be admitted that the specifications of those made by the American builders are the simplest; but it may be questioned whether, in this instance, simplicity is a merit.

The subject of the relative advantages of English and American frames is now open for discussion, and we will be glad to receive contributions relating thereto from either side of the Atlantic.

THE AMMEN RAM "KATAHDIN."

THIS vessel, which is the first war ship ever built having no means of offense except her power to ram an enemy, was launched by the Bath Iron Works at Bath, Me., on February 4. Our full-page engraving represents her as she will appear when completed, and the small sectional views show the general features of her construction. The following description of her is taken from the New York *Herald*:

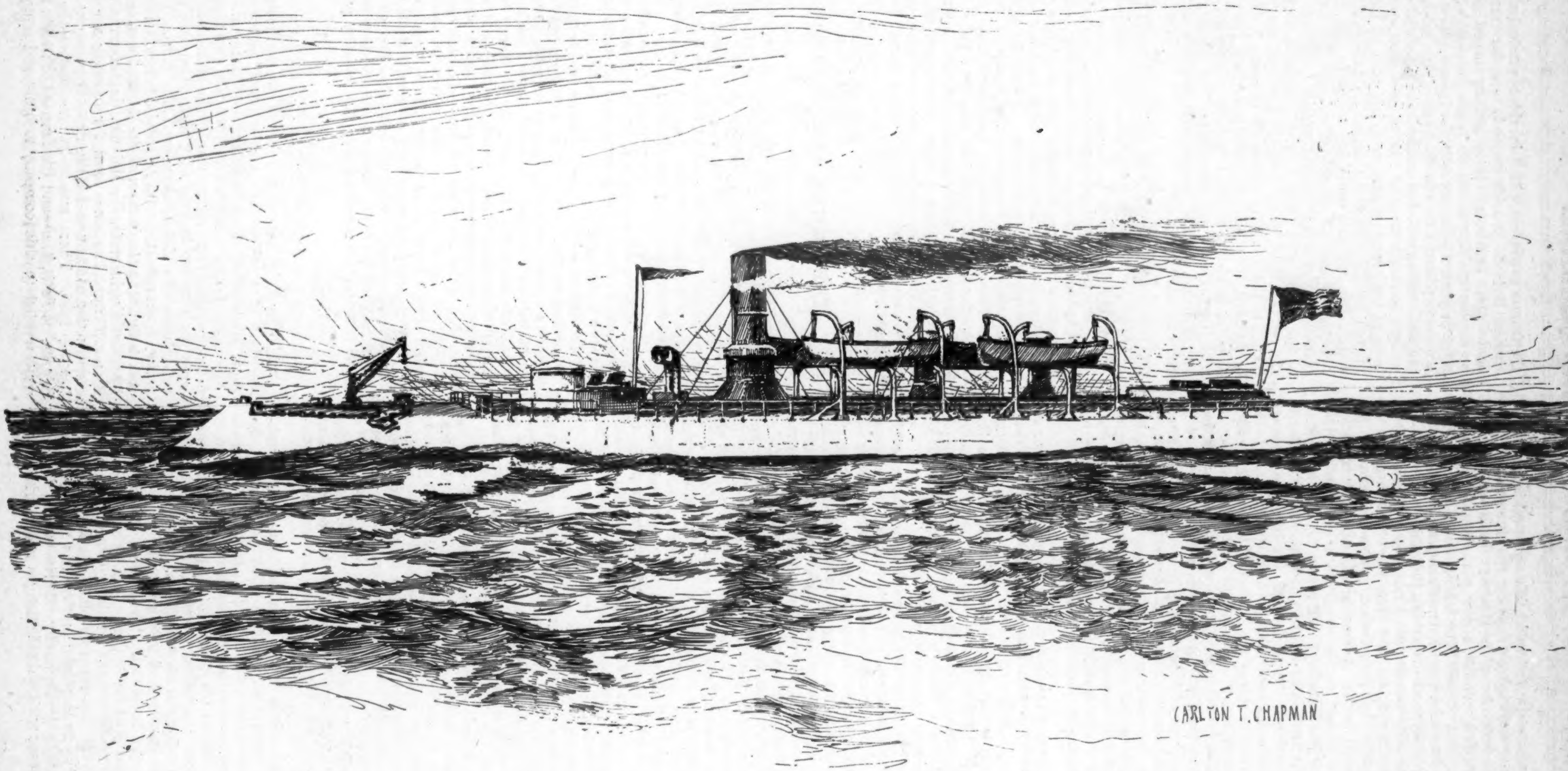
"Of course she is an experiment, and doubtless many improvements would be made if another similar craft were to be designed; but for the present the United States possesses in this ship a unique type.

"To Rear Admiral Daniel Ammen belongs the credit for her general design. He believes that in the excitement of battle such a craft, accompanying and keeping under the protection of battle-ships, could dash out against the heaviest armor-clad afloat and give a fatal blow to the enemy before the latter's guns could seriously injure the ram. It is, of course, understood that the ram is an auxiliary to the ships in the first line. The *Katahdin* could not hope to attack cruisers, for she is designed for a speed of only seventeen knots, and most cruisers could keep out of her way.

"It was hoped by most navy officers that this craft would be called the *Ammen*, after the distinguished officer to whom she is indebted for her existence; but the demands of Senator Hale, it is said, secured for her the name by which she was christened.

DESCRIPTION OF THE RAM.

"Congress, by act of March 2, 1889, authorized the construction of a twin-screw, armor-plated harbor defense ram upon the design of Rear-Admiral Daniel Ammen, United States Navy, the design being based upon his experience with and defense against rams in the war of the Rebellion. The plans were made in the Bureau of Construction and Repair under supervision of Chief Constructor T. D. Wilson, United States Navy, in consultation with Admiral Ammen. The machinery was designed in the Bureau of Steam Engineering, supervised by Chief Engineer G. W. Melville, Engineer-in-Chief, United States Navy. The time fixed for opening the bids for the construction of the vessel at the Navy Department was December 20, 1890. There was only one bidder—the Bath Iron Works, of Bath, Me.—and on January 28, 1891, the contract was awarded to this company to build and equip the vessel

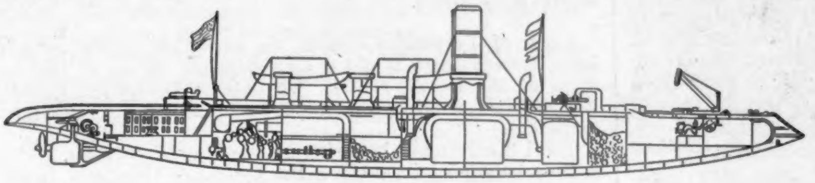


THE AMMEN RAM "KATAHDIN."

and machinery and place the armor for $930,000, to be completed in eighteen months.

"On March 27, 1891, the Department approved the proposition of the contractors to lengthen the vessel 8 ft., the corresponding increase in the displacement—133 tons—being utilized in increasing the coal supply and providing a battery of four 6-pdr. rapid-fire guns for defense against torpedo-boat attack, the original design having no battery whatever. The type and size of the boilers were also modified.

"The final dimensions of the vessel are as follows: Length over all, 251 ft.; length on the normal water-line, 250 ft. 2 in.; breadth, extreme, 43 ft. 5 in., and on the water-line, 41 ft. 6 in. The total depth from the base to the crown of the deck



LONGITUDINAL SECTION.

amidships is 21 ft., and the normal draft of water is 15 ft., the corresponding displacement being 2,155 tons.

"The lower portion of the hull is dish-shaped up to a sharp knuckle which runs all around the vessel 6 in. below the normal water-line, the angle of the knuckle amidship being about 90°. Above this knuckle the shape of the hull is a circular arc, with a radius amidships of 39 ft., rising from 6 in. below to 6 ft. above the normal water line. This curved deck is to be armor plated throughout, the thickness of the armor tapering from 6 in. at the knuckle to 2 in. at the crown of deck.

"Above this deck will rise only a conning tower 18 in. thick, a smoke-stack and ventilator (the lower portions of which will be protected by 6 in. of armor), two light barbettes, within which the guns will be mounted and skid beams carrying four boats.

THE ARMOR BELT AND COMPARTMENTS.

"Below the knuckle will extend an armor belt 5 ft. deep, one-half being 6 in. thick and the remainder 3 in. A continuous water-tight inner bottom 2 ft. from the outer skin is carried nearly the whole length of the vessel, and up to the armor shelf on each side, being divided into three water-tight portions on each side of the keel longitudinally, and these further cross-divided by 13 water tight transverse frames, thus dividing the bottom into 72 water-tight compartments. The interior of the hull is further subdivided by water-tight bulkheads, both longitudinally and transverse.

"Admiral Ammen originally wished to have a spur at the bow, so arranged that on ramming an enemy the spur would break off without injury to the rest of the hull. This has not been found practicable; and the spur—a steel casting weighing 10.8 tons—is a prolongation of the stem, to which all the forward plating is attached.

"The propelling machinery will consist of two sets of triple-expansion engines, the cylinders being respectively 25, 36 and 56 in. in diameter, the stroke of pistons being 36 in.

THE INDICATED HORSE POWER.

"The estimated maximum horse-power, with 150 revolutions per minute, is 4,800. There are two screw propellers, each 10 ft. 6 in. in diameter and 15 ft. 2 in. pitch. There are two double-ended and one single-ended cylindrical Scotch boilers, 13 ft. 6 in. in diameter, having nine furnaces each 42 in. in diameter. The total grate surface is 354 ft., and the heating surface is 12,150 sq. ft. The coal bunker capacity is 237 tons, the normal supply being 175 tons. Provision is made for carrying about 200 tons of water ballast in the double bottom, which will sink the vessel in action so that the knuckle will be about one foot below the water-line.

"The estimated speed with full power is 17 knots per hour, and this must be attained to render the vessel acceptable under the contract.

"The quarters for officers and crew are all within the armored hull, and there will be fitted complete systems of electric lighting, artificial ventilation and drainage.

"The ram will be manned by 7 officers and 91 men, of whom 71 will be in the engineer's department."

NAVAL ARCHITECT C. N. HANSCOM,

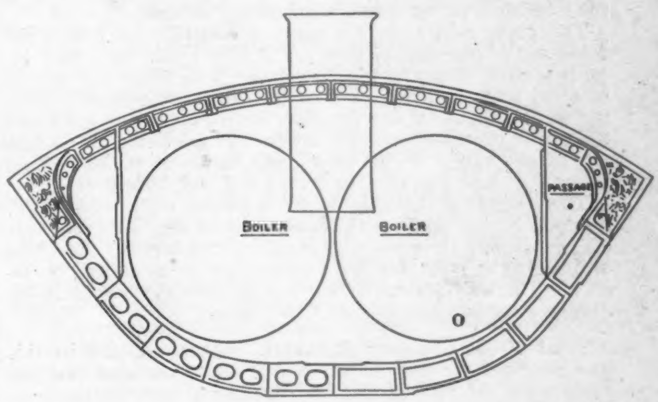
the Superintendent of the shipyard at the Bath Iron Works, is a comparatively young man, but has had an unusual amount of experience in war-ship building, and the ram constructed under his guidance will probably add much credit to an active life.

HOME NAVAL NOTES.

Transfer Boats as War ships.—Two of three gigantic ferry-boats for the North Michigan Railroad have been launched, and they are so constructed that they can be converted into war-ships at 24 hours' notice. They are of great strength and carry 24 freight cars each from Kewaunee, Wis., to Frankfort, Mich., across Lake Michigan, a distance of 60 miles, without breaking bulk. The *Ann Arbor* is capable of carrying a battery of twelve 6 in. 5 ton breech loading rifles.

Cruiser "Concord."—The Chief Engineer of this ship has been unable to return to active duty, owing to physical disabilities. It is said that much sickness and breaking down has occurred in the engineer's force of this ship, which is attributed to the extraordinary heat temperatures in her engine and fire rooms. The temperature of 165° Fahrenheit has been recorded aboard this ship, and the sickness which occurred was due directly to the strain thus imposed. Cramped fire room space and faulty ventilation appear to be the causes which have led to the defects existing aboard the *Concord*.

The "Destroyer" to be Tested at Newport.—The experiments in which the *Destroyer* is to figure at the Newport Tor-



CROSS-SECTION.

pedo Station are to determine the relative value of various steel nets, such as are now used in defending iron-clads from torpedo attack. None of the warships of the United States is provided as yet with net defenses. The result of the coming experiments will enable the Bureau of Ordnance of the Navy Department to select some one good type, or combination of types of nets. The gun which will be employed aboard the *Destroyer* is one of recent make, and, it is said, possesses numerous advantages over the original Ericsson submarine weapon.

New Armor Specifications.—The new specifications for armor under the contract for 7,000 tons of this material have been issued from the Naval Bureau of Ordnance. The contractors will find the requirements more exacting than the specifications of 1887, under which the present deliveries of armor plate are being made. The increase in the requirements is the result of the tests of armor during the past three years, in which was developed a nickel alloy and a face-hardening process. The new specifications have been revised to embrace the new conditions, which demanded stricter acceptance tests and closer inspections.

Dry-Docks at Brooklyn and Puget Sound to be Lengthened.—Secretary Tracy has approved a report of the Board of Navy Officers on the dry-dock at the Brooklyn Navy Yard that the dock could be lengthened 70 ft. on the bottom, and that this additional length would be sufficient for all the needs of the service. The main object in lengthening the dock beyond the dimensions originally planned was to accommodate such ships as the *City of New York*.

The timber dock at the Puget Sound Station will also be lengthened by 50 ft., so as to make the total length, when completed, 650 ft., the same as the dock at Brooklyn. The Navy will then have two docks, which will accommodate any ship afloat in the Atlantic or the Pacific.

The "Oregon's" Armor Plating.—The *Oregon's* 14-in. plate is the heaviest piece of armor plating as yet put up in the Unit-

ed States for test. It will be attacked by a 10-in. gun placed not more than 50 ft. from the front of the armor. The plate will be fired at until destroyed. The attack will commence at low initial velocities, and these velocities will be increased with each succeeding shot. So long as the plate holds together, little fear is felt that any of the shells will reach the wood backing. In some quarters the 14-in. plate to be tried is not deemed as good a plate in quality as some of the plates built previously on the Harvey process. The present plate, it is thought, has too high carbon and may develop cracks at a too early period of the attack.

Electricity in the Navy.—Naval officers who come up for examination hereafter must be prepared to answer any questions put to them on electrical matters. Four ensigns who were before the Examining Board recently refused to answer the questions which were propounded by the Board, and the objections were sustained. It will require an official order from the Secretary to warn other officers that they must be ready to respond to queries on the important subject which has of late years entered so fully into the work of naval officers, afloat or ashore.

The Government is spending a great deal of money to teach the cadets at Annapolis the theory and application of electricity, and it is putting electrical machinery in every ship that is building.

New Ship of the Monitor Type.—It is said that the Navy Department has under consideration designs for a new ship of the monitor type, exclusively for harbor defense.

The plans contemplate a vessel exclusively for harbor defense and of the monitor type. The ship would have very little freeboard, which would be covered with armor. It would be fitted with a turtle-back deck to deflect projectiles. Nothing would appear above the deck except the smoke-stack and the amply protected conning tower. There would be no turrets to add weight to the vessel, and the guns would be kept below decks, be elevated for firing, and then disappear.

The designer of this ship, which is termed a floating battery, is Lewis Nixon, late a naval constructor in the Navy, and now connected with the Cramp concern in Philadelphia. The idea of doing away with the turret strikes the naval experts favorably. The only feature which has an element of doubt is the disappearing carriage.—*New York Times.*

Trial of the Cruiser "Bancroft."—This, vessel, it is said, was designed for a speed of only 12 knots per hour, and the mean speed of 14.4 knots obtained during its trial trip is attributed directly to excellence of engine workmanship and good firing.

The board members were particularly struck, they say, by the absence of all leaking from the stuffing boxes. The fit of the piston rods was apparently closer than in the case of any of the new machinery built for the Navy. When the builders were questioned on this point they stated that the piston rods were first turned off and then ground down to a fit on emery wheels. To obtain the tight fit, the Moores spent $5,000 additional money in labor and tools.

Throughout the whole of the four hours' run there was not the slightest indication of heating, and at no time during the trial was it found necessary to turn water on the bearings.

The builders of the *Bancroft* state that the vessel cost in labor and material $20,000 over and above the contract price. The latter was in the neighborhood of $240,000. The bonus obtained as a result of the extra speed developed will enable the contractors to make a slight profit. The contract has at least had the effect of developing the ship plant of the Elizabethport firm, and that, too, at no loss to the firm.—*New York Times.*

The "Amphitrite's" Barbettes Completed.—The barbettes for the new double-turreted monitor *Amphitrite* are completed at the Bethlehem Iron Works. The *Amphitrite* is at present at the Norfolk Navy Yard, where she is being supplied with turrets for the protection of a four 10-in. breech-loading rifle battery that has been designed for her. Her turret armor consists of curved steel plates 11½ in. thick. This is the same thickness of metal that has been allowed to the turrets of the double-turreted monitor *Miantonomoh*, now at the Brooklyn Navy Yard.

The barbettes just turned out will be shipped in the course of a few days to the Norfolk Navy Yard and there assembled aboard the vessel. The weight of the two guns in each turret will be 50 tons.

The *Amphitrite*, to which the newly made barbettes will be supplied, is one of the five monitors for which sufficient money to complete their building was obtained during the administration of Secretary of the Navy Whitney. Of the five, *Miantonomoh*, *Monadnock*, *Terror*, *Puritan*, and *Amphitrite*, the last named will probably have no superior in the lot as a fighting ship, except, perhaps, the *Puritan*. The *Amphitrite* is a vessel of 3,815 tons, has a length of 249 ft., a beam of 60 ft., and draws 14 ft. 8 in. of water. Her armor on the hull has a thickness of 7 in. The vessel's speed will be 12 knots per hour. On a less coal-carrying capacity than that of the *Miantonomoh* it is calculated that her radius of action will be fully equal to what is credited to the latter. The *Miantonomoh*, it is claimed, can steam 1,800 knots on 330 tons of coal.

The completion of the barbettes for the *Amphitrite* will enable that ship to be commissioned during the present year. —*New York Times.*

Lack of Torpedoes.—With the exception of the torpedo boat *Cushing* there is not a torpedo afloat on any of the war ships of the United States. To date of December 31, 1891, England had afloat and in reserve no less than 2,874 Whitehead torpedoes.

The United States, in taking up the Howell torpedo, which is now handled by the Hotchkiss Ordnance Company, is also preparing to use Whitehead weapons. The little *Cushing* is provided, for instance, with a Whitehead torpedo armament for her bow tube and Howell torpedoes for use in the deck turn-table tubes. The Whitehead torpedoes ordered for the United States are being manufactured by E. W. Bliss & Co., of Brooklyn. The Howell torpedoes are being manufactured at the Hotchkiss Ordnance Shops in Providence.

The Howell torpedo passed through its successful tests over a year ago, and on one occasion, when firing from a stationary deck gun 7 ft. above water, it attained to a range of 400 yards. The average speed of nine runs was 22¼ knots, and the deviations, average of ten runs, were: Vertical, 2,764 ft.; horizontal, 21 ft.

The latest pattern of the Whitehead, known as the Woolwich design, is an 18-in. diameter projectile fitted with a bluff head, and intended especially for use with under-water discharge. A torpedo of the Woolwich pattern carries a charge of 250 lbs. of gun cotton. Successful trials with one of the latter Whiteheads record a speed of 30 knots for 700 yards, and 32 knots for 437 yards. The length of the 18-in. weapon is 16.4 ft., its weight 1,100 lbs. The explosive charge consists of 220 lbs. of gun cotton.

France and Austria have lately ordered 18-in. Whiteheads which are to have a speed of 29½ knots for 875 yards, and carry 198 lbs. of explosive. In the British Navy the 18-in. Whitehead is fitted to the larger type of war ship, and the 14-in. to the smaller type.

The new Woolwich torpedo possesses several improvements over the 1885 Whitehead; one is in the valve regulating the speed of the propellers before and after immersion, and another is in the insertion of a positive screw valve between the air and the machinery compartments, to confine the air absolutely until a short time before firing. The power of the large torpedoes, with their length and weight, is now such that they are not deflected, even in a heavy sea. The highest speed stated to have been yet attained for a short distance is 34 knots.

It is calculated that fully a year will elapse before the new ships of the United States Navy can count upon receiving a torpedo outfit.

WAR SHIPS UNDER CONSTRUCTION.

There are at present 27 vessels of war authorized or building for the United States Navy which have yet to fly for the first time a commission pennant. All but two of the 27 ships are in process of construction. The two ships authorized but not yet ordered built are the dynamite cruiser No. 2 and the torpedo-gunboat cruiser.

The vessels under construction and their probable time of readiness, from present indications, follow:

Amphitrite, double-turreted monitor, completing at Norfolk Navy Yard. Can be made ready for service in 12 months.

Puritan, barbette battle ship, at Brooklyn Navy Yard. Requires 18 months' work at present rate.

Monadnock, double-turreted monitor, completing at Mare Island Navy Yard. Requires 18 months more.

Terror, double-turreted monitor, completing at Brooklyn Navy Yard. Can be made ready for service in nine months.

Texas, coast-defense battle ship, completing at Norfolk Navy Yard. Can be made ready for service in 12 months.

Maine, armored cruiser, at Brooklyn Navy Yard. She is ready for service save for the placing of her armor. The

Maine will probably be delayed fully 12 months awaiting this armor.

Brooklyn, armored cruiser, awarded to the Cramps of Philadelphia to build. It will be fully three years before the ship is found in commission.

New York, armored cruiser, fitting out at the Cramps' yard, Philadelphia, for service. The *New York* is booked to participate in the Columbian naval review as flagship. She is reported as able, probably, to go into commission by March 31.

Katahdin, harbor defense ram, completing at the yards of the Bath Iron Works, Bath, Me. Will be ready for service in 12 months.

Massachusetts, coast-line battle ship, building at the Cramps' establishment, Philadelphia, will be ready for launching by May 1. The *Massachusetts* will probably require two years' work before being ready for commissioning.

Indiana, coast-line battle ship, building at the Cramps' establishment, and will be launched early in March. She will take 20 months' additional work.

Oregon, coast-line battle ship, building at the Union Iron Works, San Francisco. The *Oregon* will not be ready for service inside of 30 months.

Iowa, seagoing battle ship, will be built by the Cramps of Philadelphia. She will not be ready for commissioning in less than three years.

Olympia, cruiser, completing at Union Iron Works, San Francisco, will be ready for commissioning in 12 months.

Cincinnati, cruiser, completing at Brooklyn Navy Yard, will be ready for commissioning in 12 months.

Raleigh, same as *Cincinnati*, building at the Norfolk Navy Yard.

Montgomery, cruiser, completing at Columbian Iron Works, Baltimore. She will be commissioned prior to May 1.

Detroit, cruiser, same as *Montgomery*.

Marblehead, cruiser, completing at Harrison Loring's Yard, South Boston, will be ready for commissioning by September 1.

Columbia, cruiser, building at the Cramps' establishment, will be ready for service in 18 months.

Minneapolis, cruiser, building at the Cramps' establishment, will be ready for service in 20 months.

Machias, gunboat, completing at the Bath Iron Works, will be commissioned by May 1.

Castine, gunboat, building at Bath Iron Works, will be ready for commissioning by July 1.

Torpedo Boat No. 2, building at Iowa Iron Works, Dubuque, Iowa, will be ready for service by September 1.

Bancroft, practice cruiser, completing at S. L. Moore's yard, Elizabethport, N. J. The *Bancroft* has undergone her official trial for acceptance, and will be ready for commissioning in the course of the next six weeks.—*New York Times.*

NEW SHIPS FOR THE LAKES.

Mr. John Craig, President of the Craig Ship-building Company, of Toledo, O., recently reported the following conditions existing in the ship yards on the lakes :

"Nearly every yard on the lake system," he said, "is doing about all the work it can handle. At Bay City, Mich., the Wheelers are building two steel steamers, which are designed to be the largest ships ever seen on the great lakes. They are for the firm of Whitney, Avery & Hawgood. The keel length of each ship will be 360 ft. It is noteworthy that the engines of the two ships will be placed in the center of the vessels, instead of well aft, as in the case of the majority of lake steamers. In addition, the Wheelers are building three large modern steamers and several tugs.

"At Cleveland, the Globe Ship-building Company is building, in addition to freight steamers, two ships for the Great Northern Steamship Company, which, I understand, are designed to make the run between Buffalo and Duluth in fifty hours. So far as I could glean in recent conversation with fellow lake men, the opinion is held that the two boats will consume in fuel and repairs all money that it is possible to make out of them. The frames for one of the ships are now up and are nearly ready for plating. The Globe Ship-building Company is not understood among lake men to be guaranteeing speed. The company is merely building the ships as called for by the designs of Miers Coryell, the constructor in charge.

"The Cleveland Ship-building Company is building ten large steel steamers. At Detroit the Detroit Dry Dock Company is building a magnificent freight steamer for service in the Mackinaw Straits. The new vessel is designed to be an ice fighter. She will have a run of twelve miles to make, and this she will endeavor to do the year round. She will carry freight cars on rails laid on deck, and thus obviate breaking bulk. She is fitted with fore and stern screws operated on independent shafts and by independent engines. The bow screw is meant for service in crushing and breaking ice. The ice problem is the only difficult one which has to be solved in the Mackinaw Straits, and the problem becomes a momentous one in the winter season. The new ice fighter will cost about $350,000.

"At Chicago, the Chicago Ship-building Company is busy on a couple of freight steamers. The Union Dry Dock Company, of Buffalo, is building a fast freight steamer for the Erie Railroad for service between Toledo and Buffalo. This freight steamer will break freight bulk at each end of the route. Several tugs and fire boats are building at Buffalo. David Bell, of that place, is building a revenue steamer for the Government for service at the port of Chicago."

Mr. Craig was asked what general impression prevailed as to the causes of the disasters to the *Western Reserve* and the *Gilcher*, two large freight steamers lost in Lake Erie last fall.

"The *Western Reserve*," he said, "undoubtedly broke in two. This belief has become the generally accepted one. There is not, however, the same unanimity of opinion concerning the cause of the loss of the *Gilcher*. Personally I am inclined to think that the latter ship struck a derelict. The *Western Reserve* undoubtedly received, in the course of her construction, some faulty hull material."

"What precautions have been taken," Mr. Craig was asked, "on the part of lake men to guard against future faulty construction ?"

"The matter has been under consideration for some time by the Lake Owners' Association, the Carriers' Association and the Inland Lloyds. It has been decided that all ships now on the lakes shall be examined and standardized by representatives of the Bureau Veritas, the French Lloyds, and the standardization made by them shall be accepted by the associations. The work of inspection is now in progress, and is under the general charge of Captain F. D. Herriman, the Chief Inspector of the Bureau Veritas. As soon as this authority passes upon a ship the vessel is open to classification in the Inland Lloyds. On the whole the effect of last year's disasters will tend to the building of abler vessels and ships having at least closer attention paid to their hull material.

"The general outlook for the coming year promises to be better than for many years. Lake ships still continue to pay about 25 per cent. upon the capital invested in them, and so long as this continues ship-building in the Northwest will prosper. I well remember when grain freight paid as high as 32 cents per bushel from Milwaukee to Buffalo, but that was at a time when lake tonnage rarely exceeded in carrying capacity 500 tons per ship. Now we find the freight rates down to two cents per bushel, and ships engaged in the carrying trade capable of handling 2,500 tons and more of cargo. As the rates have decreased, carrying capacity has increased, and, as a consequence, the general profits are to-day about equal to what they were in former days, when rates were so extraordinarily high.

"All new vessels of over 2,000 tons burden are, as a rule, being built of steel. Smaller vessels continue to be built of wood. Steel is, however, becoming the popular material, and I think will prove the more economical choice in the long run. As yet we have not had sufficient experience with steel ships to furnish any accurate data on this subject."

Mr. Craig is the designer and builder of the two novel freight steamers, *Ann Arbor No.* 1 and *Ann Arbor No.* 2, constructed recently for the Toledo, Ann Arbor & North Michigan Railroad, and now engaged in carrying freight cars across Lake Michigan the year round. The two boats are deemed by Government inspectors to be the strongest vessels on the lakes. Mr. Craig says that the two steamers have proved beyond question their ability to keep open communication on Lake Michigan in the most severe weather.

Mr. Craig adds that MacDougal, of West Superior, is building no less than five whaleback steamers. The type is still unpopular, "but somehow our lake men are being forced to take them up," Mr. Craig says.

In addition to the above we publish extracts from a private letter recently received from West Bay City, Mich., regarding the ship-building interests at that place, with data concerning other work along the shores of the great lakes.

"There was a most successful launch on February 4 of a big steel freighter for Captain John Mitchell and others of Cleveland. The feature of the launch was the necessity of cutting sufficient ice out of the river to let her drop in. The ice was about 18 in. thick. She slid in about 5 P.M., and her dimensions are as follows : Length of keel, 328 ft.; over all, 345 ft.;

beams, molded, 41 ft. 6 in.; extreme, 42 ft. 6 in.; depth, 24 ft.; three pole-masts, fore-and-aft schooner rig; triple-expansion engines 20 in., 32½ in., 55 in. × 42 in. stroke; boilers, 2 in number, cylindrical, 13 ft. diameter, 12 ft. 8 in. long, 160 lbs.; steam propeller, 12 ft. 6 in. diameter, 14 ft. 6 in. pitch.

"The very severe weather experienced during the last two months has told a great deal on the work in hand, as the men have been absolutely unable to put in full time on account of the cold. There are now about 1,300 men on the pay-roll, and everything is rushing for all it is worth and as well as the weather permits. There are now 10 vessels in course of construction, and we are not idle. In the machine shop six engines are now building, and we are about the busiest on the lakes, if not the busiest. There are two triple-expansion engines of 23 in., 37 in. and 63 in. × 44 in. stroke; two triple-expansion of 20 in., 32½ in and 55 in. × 42 in. stroke; one triple of 17 in., 28 in. and 47 in. × 44 in. stroke, and a compound engine for a tug of 11 in. and 24 in. × 14 in. stroke; besides the above we are compounding the engines of a small wooden steam barge. Considering that only two or three months have elapsed since really starting in to build our own engines, it says a great deal for the go-ahead policy of F. W. Wheeler & Company.

"The boats are as follows:

"Steamer No. 93, steel, the dimensions of which are given you above. She was launched February 4.

"Steamers Nos. 94 and 95, steel, for Hawgood & Avery, of Cleveland, and D. Whitney, of Detroit, respectively. Length of keel, 360 ft.; over all, 377 ft. 6 in.; beam, molded, 44 ft.; extreme, 45 ft.; depth, molded, 25 ft.; two pole-masts; engines, triple-expansion, 23 in., 37 in. and 63 in. × 44 in. stroke; boilers, 3, cylindrical, 12 ft. 6 in. diameter, 12 ft. 8 in. long, 160 lbs. pressure; propeller, 14 ft. diameter, 16 ft. 6 in. pitch.

"Schooner No. 96, wood, for Colin McLachlan and others, Port Huron, four-masted, fore-and-aft rig. Length of keel, 251 ft.; length over all, 267 ft.; breadth, extreme, 41 ft. 2 in.; depth, molded, 18 ft. ½ in.

"Steamer No. 97, wood, Hawgood & Canfield, Cleveland. Length of keel, 290 ft.; over all, 307 ft.; beam, molded, 41 ft.; extreme, 42 ft.; depth, molded, 23 ft.; only foremast; engines, triple-expansion, 20 in., 32½ in. and 55 in. × 42 in.; boilers, two, cylindrical, 12 ft. 6 in. diameter, 12 ft. 8 in. long, 160 lbs. pressure; propeller, 12 ft. 6 in. diameter, 14 ft. 6 in. pitch.

"Steamer No. 98, wood, Bradley and others, Cleveland. Length of keel, 270 ft.; over all, 284 ft.; beam, 39 ft. 4 in.; depth, molded, 22 ft.; three-masted, fore-and-aft schooner rig; engines, triple-expansion, 17 in., 28 in. and 47 in. × 44 in. stroke; boilers, two, cylindrical, 11 ft. long, 12 ft. diameter, 170 lbs. pressure.

"Schooner No. 99, wood, John Francombe, of Detroit. Length of keel, 201 ft. 8 in.; over all, 209 ft.; beam, molded, 34 ft.; depth, molded, 14 ft. 6 in.; three-masted, fore-and-aft schooner rig.

"Steamer No. 100, steel, building on account. As this is the firm's one hundredth ship, they are going to name her the *Centurion*. Length of keel, 360 ft.; over all, 378 ft.; beam, molded, 44 ft.; extreme, 45 ft.; depth, molded, 26 ft.; two masts (pole); engines, triple-expansion, 23 in., 37½ in. and 63 in. × 44 in. stroke; boilers, three, cylindrical, 12 ft. 6 in. diameter, 12 ft. 8 in. long, 160 lbs. pressure; propeller, 13 ft. 6 in. diameter, 17 ft. pitch. We have made a great departure in adopting the ocean style of craft in steamers Nos. 94, 95 and 100, by placing engines and boilers directly amidships, the only other boats built on the lakes like that being the *Owego* and *Chemung*, designed by George Mallory, and built at Buffalo; they are, however, much smaller than these boats. Since the unfortunate losses of both the *Western Reserve* and the *Gilcher*, every one is trying to lessen the strains to which these long, wide and shallow boats are subjected, and as placing the machinery amidships helps to a great extent, and there seems nothing really to prevent their being placed there, Mr. Wheeler has decided to take the lead and prove to the country that it can be and will be done; our scantlings, although according to the American Shipmasters' Association, are really in excess of both the English Lloyds and the American Shipmasters' Association rules.

"Schooner No. 101, wood, Captain William Forbes and others, Port Huron. Four-masted, fore-and-aft rig; length of keel, 270 ft.; 286 ft. over all; beam, molded, 41 ft.; extreme, 42 ft.; depth, molded, 20 ft.

"Tugboat No. 102, wood, Captain Armstrong, Bay City, for fire service station at Saginaw. Length of keel, 53 ft.; over all, 60 ft.; beam, molded, 15 ft.; depth, 7 ft. 6 in.; engines, F. & A. compound, 11 in. and 24 in. × 14 in. stroke; fire-box boiler, 4 ft. 9 in. diameter, 10 ft. 6 in. long, 100 lbs. pressure. She will be fitted with fire-pumps of great power, and every appliance for speedily quenching flames."

CAR-COUPLER BILL.

We give below the full text of the bill which has passed the Senate, requiring the use of automatic couplers and continuous brakes by the railroad companies of the United States. The bill was passed on the afternoon of February 11 by a vote of 39 to 10.

Section 1. That from and after the first day of January, 1898, it shall be unlawful for any common carrier engaged in inter-State commerce by railroad to use on its line any locomotive engine in moving inter-State traffic not equipped with a power driving-wheel brake and appliances for operating the train-brakes system, or to run any train in such traffic after said date that has not a sufficient number of cars in it so equipped with power or train-brakes, that the engineer on the locomotive drawing such train can control its speed without requiring brakemen to use the common hand-brake for that purpose.

Sec. 2. That on and after the first day of January, 1898, it shall be unlawful for any such common carrier to haul or permit to be hauled or used on its line any car used in moving inter-State traffic not equipped with couplers, coupling automatically by impact, and which can be uncoupled without the necessity of men going between the ends of the cars.

Sec. 3. That when any person, firm, company, or corporation engaged in inter-State commerce by railroads shall equip a sufficient number of its cars so as to comply with the provisions of Section 1 of this act, it may lawfully refuse to receive from connecting lines of road or shippers any cars not equipped sufficiently in accordance with the first section of this act, with such power or train-brakes as will work and readily interchange with the brakes in use on its own cars, as required by this act.

Sec. 4. That from and after the first day of July, 1895, until otherwise ordered by the Inter-State Commerce Commission, it shall be unlawful for any railroad company to use any car in inter-State commerce that is not provided with secure grab-irons or handholds on ends and sides of each car for greater security to men in coupling and uncoupling cars.

Sec. 5. That within 90 days from the passage of this act the American Railway Association is authorized hereby to designate to the Inter-State Commerce Commission the standard height of drawbars for freight cars, measured perpendicular from the level of the tops of the rails to the centers of the drawbars, for each of the several gauges of railroads in use in the United States, and shall fix a maximum variation from such standard height to be allowed between the drawbars of empty and loaded cars. Upon their determination being certified to the Inter-State Commerce Commission, said commission shall at once give notice of the standard fixed upon to all common carriers, owners, or lessees engaged in inter-State commerce in the United States by such means as the commission may deem proper; but should said association fail to determine a standard as above provided, it shall be the duty of the Inter-State Commerce Commission to do so before July 1, 1894, and immediately to give notice thereof as aforesaid, and after July 1, 1895, no cars, either loaded or unloaded, shall be used in inter-State traffic which do not comply with the standard above provided for.

Sec. 6. That any such common carrier using any locomotive engine, running any train, or hauling or permitting to be hauled or used on its line any car in violation of any of the provisions of this act, shall be liable to a penalty of $100 for each and every such violation, to be recovered in a suit or suits to be brought by the United States District Attorney having jurisdiction in the locality where such violation shall have been committed, and it shall be the duty of such District Attorney to bring such suits upon duly verified information being lodged with him of such violation having occurred, and it shall also be the duty of the Inter-State Commerce Commission to lodge with the proper District Attorneys information of any such violations as may come to its knowledge, provided that nothing in the act contained shall apply to four-wheeled cars or to locomotives used in handling such trains.

Sec. 7. That the Inter-State Commerce Commission may, from time to time, upon full hearing and for good cause, extend the period in which any common carrier shall comply with the provisions of this act.

Sec. 8. That any employé of any such common carrier who may be injured by any locomotive, car, or train in use contrary to the provisions of this act, shall not be deemed thereby to have assumed the risk thereby occasioned, although continuing in the employment of such carrier after the unlawful use of such locomotive, car, or train had been brought to his knowledge.

SHELLS WITH HIGH EXPLOSIVES.

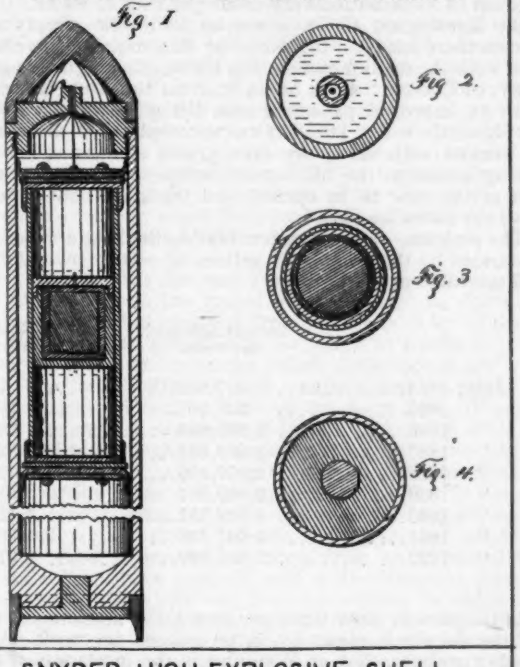
(From *Annual No. XI.* of the Office of Naval Intelligence.)

THE most important experiments undertaken during the past year by private parties to develop the use of high-explosive projectiles in powder-charged guns have been those of Justin in the United States and Snyder in South Wales.

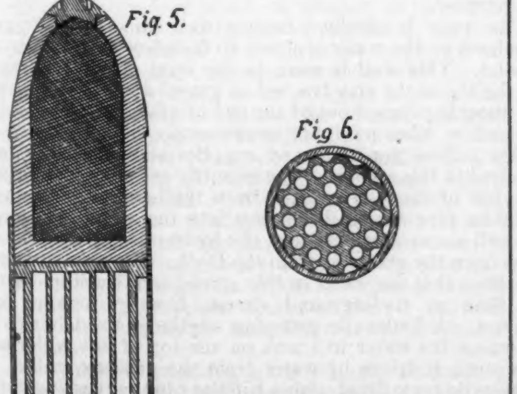
THE JUSTIN SHELL.

To relieve the shock of discharge, Dr. Justin places his explosive, surrounded by a compressible absorbent, in wooden boxes which are contained in a cylindrical carrier. This carrier is of less diameter and shorter than the body of the shell, and is fitted with leather disks having overturned edges, which are secured on the top and bottom of the carrier by washer heads and rubber relief-disks. A wire holding the carrier in a forward position is broken upon shock of discharge; the body of the shell moving forward, the inertia of the carrier forces it to the rear, compressing the

JUSTIN HIGH-EXPLOSIVE SHELL



SNYDER HIGH-EXPLOSIVE SHELL



air behind it. This compressed air forces its way in front of the carrier by passing through ports in the rear leather disks, so that the cushioning effect of the compressed air is regulated by the sizes of these ports. The shell is exploded on impact by either a percussion or a delayed-action fuse. It is shown in figs. 1, 2, 3 and 4.

Dr. Justin ascribes the failures of previous experiments to weakness of the bases of his projectiles.

At Perryville, N. Y., September 1 and 10, 1891, shells were successfully fired from a 5-in. Parrott rifle and an 8-in. Blakely. On December 22, 1891, a shell containing 30 lbs. explosive gelatin was fired with a charge of 30 lbs. brown prismatic powder from a 6-in. Parrott rifle at a bank of earth 75 ft. distant; it penetrated 17 ft. without exploding Another unfused shell, charged with 8¼ lbs. explosive gelatin, failed to explode on impact when fired at rock 690 ft. distant.

A modified form of shell in which the rear face of the carrier is convex, so as to diminish the rear surface area which tends to rotate the charge with the body of the shell, due to the rifling, and thus decrease friction, was tested June 20, 1892, with the following results:

1. Five shells, each weighing 56¼ lbs., with a charge of 6¼ lbs. explosive gelatin, were fired from a 5¼-in. Parrott gun. Four were fired against a stone precipice, the fifth through a ⅝-in. steel plate and 16 ft. of earth, without exploding.

2. A projectile weighing 60¼ lbs., with a charge of 5 lbs. explosive gelatin, was fired from the 5¼-in. Parrott gun, passed through a ⅝-in. steel plate and was exploded in the butt by delayed-action fuse.

3. Three shots weighing 225 lbs. each, with charge of 34 lbs. explosive gelatin, and three weighing 214 lbs. each, with charge of 36½ lbs. explosive gelatin, were fired successfully from a 9-in. Blakely gun.

4. A projectile weighing 254 lbs., charged with 30 lbs. explosive gelatin, was fired from a 9-in. Blakely gun; it perforated 3 in. of steel and was exploded in backing by the delayed-action fuse.

A member of the company is quoted as saying that since June, 1891, one hundred 6-in. projectiles, 3 ft. long, have been fired without accident.

THE SNYDER SHELL.

The method employed by Snyder to relieve the shock of discharge is shown in figs. 5 and 6.

The projectile has the usual ogival head, a solid base, and the rear half of its cylinder is turned down to a less diameter than the caliber of the gun. Fitted over its base is a brass cylinder, with solid base and open head, containing a fluted rubber cylinder, which is pierced with about 30 holes. When the discharge occurs the pressure of the powder gases shortens the cylinder, compresses the rubber and contained air which produce the cushioning effect, and bulges the cylinder so that it expands and takes the rifling of the bore of the piece. The base cylinder drops off soon after leaving the muzzle. These projectiles can be used with either rifled or smooth-bore guns.

Experiments were conducted with this system of projectiles at Aberdare, South Wales, October 5, 1891.

Using a 7-in. Blakely muzzle-loading rifle and a 6-in. Armstrong breech-loading rifle, projectiles weighing 229 lbs. and 218 lbs., respectively, containing 10 lbs. of explosive gelatin of 4 per cent. camphor, several rounds were fired with low velocities at 3-in. and 6-in. wrought-iron targets. No accidents nor premature explosions occurred, but the effects on the targets were not very marked, owing, probably, to insufficient delayed action on impact, or to low velocities.

On October 26, 1891, a 7-in. shell, containing a bursting charge of 12½ lbs. of explosive gelatin, was fired through a ½-in. steel plate and buried itself in a hill 1,200 ft. distant without exploding. Another shell, containing an explosive charge of 7½ lbs. of dry gun-cotton and ¾ lb. of explosive gelatin, was also successfully fired with the usual powder charge.

It being considered doubtful whether these projectiles would safely withstand the pressures developed with high velocities, two rounds were fired on February 1, 1892. all details being conducted in the presence of two retired English army officers. The object of this trial was to give conclusive proof of the safety with which explosive gelatin could be fired in these shells from powder guns.

The gun used was a 6-in. Armstrong breech-loading rifle, and the details of the shots were as follows:

1. Total weight of loaded shell, 78 lbs.; rubber buffer and case, 21 lbs. The charge was 7 lbs. nitro-gelatin. Charge of gun, 50½ lbs. brown prismatic powder; initial velocity, 1,284 foot-seconds. The low velocity was attributed to the damp powder used.

2. Total weight of loaded shell, 76 lbs.; rubber buffer and case, 21 lbs. The charge was 7 lbs. of nitro-gelatin. Charge of gun, 45½ lbs. black prismatic powder; initial velocity, 1,766 foot-seconds. The projectile used had two ring grooves cut in its head to bite when striking at an angle.

Both of these projectiles exploded on impact with a soft bank. Portions of the brass cases, showing rifling impressions, were found scattered along the line of flight.

RAPID BLUE PRINTING IN CLOUDY WEATHER.

A correspondent of the *Engineering News* says that while experimenting with blue-printing processes with the object of getting bright blues and clear white lines, he found that after the usual washing a bath of quite dilute acid, such as hydrochloric, or, better, oxalic, would often greatly improve the clearness of the prints, a marked cause of dirty blues being a gradual altering of the solutions even when kept separate till just before using, though poor quality of the ammonia citrate of iron seemed to have much to do with the results.

During the experiments he also found that an addition of oxalic acid to the ordinary blue-print mixture materially lessened the time of necessary exposure. The solutions used were:

1. Ammonia-citrate of iron, 120 grains; water, 1 fluid ounce; to which is added a few drops of strong ammonia solution till the odor is quite perceptible.
2. Potassium ferricyanide, 105 grains; water, 1 fluid ounce.
3. Saturated solution of oxalic acid.

Equal quantities of (1) and (2) are taken (*a*); and after being mixed (3) is added as required and the mixture used at once.

Taking, say, in the proportion of 10 ounces of the mixture (*a*) and adding thereto (*b*) 1 ounce; (*c*) 2 ounces; or (*d*) 3 ounces of (3); the relative rapidity of the coated papers will be closely, in very dull light, as 1; 2½ : 5; 10, (*d*) paper being thus about 10 times as rapid printing as (*a*) in the light mentioned. For example, a print was made from a tracing on linen in 35 minutes on February 25, 11.30 A.M., on (*d*) paper during a snow storm, the light being quite dull, while ordinary paper takes the greater part of a day in an equal light.

This great difference only holds good in dark, cloudy weather; as, if comparisons are made in direct sunlight, (*d*) paper is only three to four times as rapid as (*a*). An explanation of this probably is, that a weak light that will reduce to oxalic acid mixture (partly ferric oxalic) has but a faint starting or continuing action on the ferric citrate, while with a strong light both commence at once.

For all ordinary purposes it is better not to use a greater percentage than 20 per cent. (*c*) of the oxalic acid solution, as it is difficult to get the lines to wash white with higher percentage, even with thick black lines on the tracing or negative; and the more sensitive the paper the shorter time it will keep good even in the dark, and also the greater care required in its preparation and use.

HYDRAULIC POWER IN LONDON.

Among the systems of transmitting power to long distances hydraulic power is coming rapidly to the front, and indeed has already held that position for some years in England. We are indebted to a recent issue of the *Engineer* for a description of the plant of the London Hydraulic Power Company, the magnitude of whose operations is rendered tolerably evident by the fact that there is scarcely an important thoroughfare in London in which men may not be seen from time to time laying cast-iron pipes, whose enormous thickness bears ample testimony to the most untechnical passer-by that they are not ordinary gas or water mains.

The London Hydraulic Power Company, with which is associated the General Hydraulic Power Company, has been in existence for about nine years. The general company has the same objects as the London company, but its operations are not confined to any particular city or area. It undertakes the supply of hydraulic power, either in England or abroad, wherever a sufficient demand exists for a system of public supply and the general conditions are favorable.

The general principle involved is, as we have said, pumping water into mains laid in the streets, from which service pipes are carried into the houses to work lifts, or three-cylinder motors when rotary power is required. In one or two cases, however, a small Pelton wheel has been tried working under a pressure of over 700 lbs. on the square inch. The efficiency is over 70 per cent., an extraordinarily high duty. Over 55 miles of hydraulic mains are at present laid in London between Kensington and the London Docks (Shadwell Basin) on the north side, and between Westminster Bridge and the Surrey Docks on the south side of the river, thus embracing nearly the whole of the city, Westminster, Kensington, Wapping, and Southwark. The mains are kept charged by pumping engines located at the Central Pumping Station, Falcon Wharf, Blackfriars; at Millbank Street, Westminster; and at Wapping. A fourth station is in progress in North London, close to the City Road basin. The reservoir of power consists of capacious accumulators, loaded to a pressure of 800 lbs. per square inch, thus producing the same effect as if large supply tanks were placed at 1,700 ft. above the street level. The water is taken from the Thames, or from wells, and all sediment is removed therefrom by filtration before it reaches the main engine pumps.

The power is available day and night, and on Sundays, all the year round, at a pressure of over 700 lbs. per square inch; a pressure which enables small machines to perform a large amount of work with a very small quantity of water.

At Kensington Court a special hydraulic supply to the houses there has been furnished by this company, in conjunction with the manufacturers, the Hydraulic Engineering Company, of Chester. Each house built on the estate is furnished with an improved passenger ram lift on Ellington's system, for domestic use. The lifts are so constructed that they can be worked with safety by even young children. The doors giving access to the lift cannot be opened until the car is at rest at the door to be opened, and the lift cannot be worked until the doors are closed.

The progress of the London Hydraulic Power Company is illustrated by the number of gallons of water power delivered and machines at work during

	Gallons delivered per week.	Number of machines.
July, 1884	317,816	96
" 1885	957,907	235
" 1886	1,379,846	387
" 1887	1,694,621	527
" 1888	2,377,190	720
" 1889	3,339,067	917
" 1890	4,223,751	1,133
" 1891	5,027,616	1,381
" 1892	5,998,249	1,676

At the present time there are over 1,750 machines at work, and the supply is about 6,500,000 gallons per week. Of the existing stations, that at Wapping is the most powerful and complete. Here the water is obtained from a well sunk for the purpose.

The water is obtained from a well sunk for the purpose. The level of the water is about 40 ft. below the surface of the ground. This well is sunk to the level of the London clay. On the top of the clay is a bed of gravel about 8 ft. thick, and the water is pumped out of the bed of gravel. The yield from the well is, when pumping continuously day and night, about 16,000 gallons per hour, and supplies about half the amount required at this station. The quantity required in addition to the yield of the well is taken from the London Dock through a siphon pipe which discharges into the well. The pipes in the well are so arranged that the hydraulic pumps will either draw from the gravel or from the Dock. There is some reason to believe that the water in this gravel bed is neither more nor less than an underground stream flowing parallel to the Thames. A hydraulic pumping engine is fixed in this well, and raises the water to a tank on the top of the boiler house. This pump is driven by water from the pressure mains. The pump cylinder is fitted with a tubular plunger passing through packing at the mouth of the cylinder, and this main plunger itself forms a hydraulic cylinder, fitted with a stationary tubular plunger, through which the high-pressure water passes into and out of the interior of the main plunger. On each side of the main cylinder is a small cylinder; the two plungers of these are connected to a cross-head attached to the main plunger. The small cylinders are always in connection with the high-pressure water-supply, which acts on their plungers with sufficient force to cause the main plunger to make its

back stroke. The stationary plunger is alternately put in communication with the high-pressure supply and with the discharge by means of a slide-valve, which is moved to and fro by the hydraulic pressure acting alternately in a short cylinder at each end of it. The alteration of the pressure in these last-mentioned cylinders is effected by the movement of a secondary slide-valve, which is shifted by tappets on a rod attached to the main plunger. The speed with which the main slide-valve moves is controlled by more or less throttling the passage from the secondary slide-valve to its cylinders. The arrangement permits of a variation of the speed of travel of the main valve, and a pause of any desired length is obtained during reversal of the motion of the plunger. The main plungers are 20 in. diameter, 4 ft. stroke, and work at a speed of 10 strokes per minute.

The water from the well is pumped into tanks over the boiler-house. Here the water settles, and is then collected by floating pipes and passes through filters to the underground filtered water reservoirs. The main engine circulating pumps draw the water from the reservoirs, and force it through the surface condensers into the filtered water section of the tanks over the boiler-house. From these tanks the main engine pumps take their supply under the tank pressure, and force it into the hydraulic power mains. The total reservoir capacity at the station is 800,000 gallons, which is sufficient for one day's supply from the station. The plant for pumping and filling is designed with the intention that it should be at work day and night, while the main engines do not work as a rule more than twelve hours. During the night the hydraulic pumps in the well are worked from the power supplied from the central station, Falcon Wharf, Blackfriars. As a rule, therefore, the main engines start in the morning with all tanks full, and end their day's work with them half empty. These hydraulic pumps are not only economical themselves, but, as it will be seen, give greater facilities for working day and night, as they are quite independent of the supply plant at the particular station where they are fixed. The night watchman stops the pumps and filters when the tanks are full. That is all he has to do.

It is essential that the water used should be clean. The water obtained from the gravel leaves little to be desired in this respect, but that obtained from the docks is by no means pure, and elaborate precautions are taken to purify it. The storage tank extends over the whole boiler-house and coal store. The tank is divided, and a certain amount of mud is deposited here. From thence, as we have said, it passes through the surface condenser of the engines, and it is turned into a set of filters eight in number. The body of the filter is a cast-iron cylinder, containing a layer of granular filtering material resting upon a false bottom; under this is the distributing arrangement, affording passage for the air, as described below; and under this the real bottom of the tank. The dirty water is supplied to them from an overhead tank into which it has been pumped, and is distributed to them by a pipe running the whole length of the building in which they are placed. After passing through the filters the clean effluent is run into a large tank, and is then again pumped into the clean water tank, from which the pumping engines derive their supply. The cleaning of the filters, which is done at intervals of twenty-four hours, is effected so thoroughly *in situ*, that the filtering material never requires to be removed. The operation is as follows: Air is injected by a steam blower, through the distributing arrangement mentioned above, and at the same time a reverse current of water is passed through the filters; this causes the whole of the filtering materials and the impurities contained in it to boil up, as it were. The most violent agitation takes place, and the particles of dirt are thoroughly loosened by the friction of the air and water, without damage to the grain of the filtering material; the dirty water passes through cylindrical screens in the filters themselves, which allow all the impurities to pass away to the drains, while preventing the loss of any of the filtering material. After a few minutes the effluent, which at first starting is like liquid mud, becomes clearer as the air and water do their work, and regains the same tinge as the original sample to be filtered.

The water used for washing is the ordinary unfiltered water. As soon as the cleaning, which occupies but a very short time, has been effected, the filters are ready for work again. The total quantity which these eight filters are guaranteed to deal with is 35,000 gallons per hour. By a suitable arrangement of pipes and valves, a minimum of labor is necessitated, only the opening and shutting of the valves being needed, no manual labor of any kind in the washing of the filters being required. The water is rendered so clean by this process that even if allowed to remain for many days in the tall test glasses which are employed for ascertaining its purity no deposit of any kind is to be found in the bottom, showing that all the mechanical impurities have been eliminated.

The engine house contains six sets of triple-expansion engines, constructed by the Hydraulic Engineering Company on Ellington's system. The cylinders are 15 in. + 22 in. + 36 in. × 24 in. The cranks are set at 120°. Each cylinder drives a single plunger pump with a 5 in. ram, secured directly to the crosshead, the connecting-rod being double to clear the pump. The boiler pressure is 150 lbs. on the square inch. Each pump will deliver 300 gallons of water per minute, under a pressure of 800 lbs. to the square inch, the engines making about 61 revolutions per minute. This is a high velocity, considering the heavy pressure; but the valves work silently and without perceptible shock. All the cylinders are jacketted, and unusual care has been taken to keep them drained back into the boilers by gravitation. The drain-pipes are large and carefully laid, to prevent any accumulation of water in the bends. The steam-pipes are of wrought iron, laid upon the round-about system. Every portion is practically in duplicate. All the steam-pipes are trapped, and the condensed steam from the traps is collected in a tank and returned by feed-pumps to the boilers. The utmost care has indeed been taken to prevent water finding its way into the cylinders. The engines as a result are found to be very economical, the consumption of steam being 14.1 lbs. per horse per hour. The engines are fitted with surface condensers, as we have already stated. The casing of the condenser forms a part of the engine frame, and each set has its own independent air, circulating, and feed-pumps, driven from the crosshead of the intermediate cylinder through links and rocking shaft, as in marine engines. The circulating water is taken, as already explained, from the filtered water reservoir below the station yard, and is delivered into the filtered water division of the boiler-house tank, from whence it is drawn by the main pumps and pumped into the hydraulic mains. The circulating pumps are of ample capacity to raise the necessary amount of suction water for their respective engines; they thus perform the double duty of circulating and lift pumps. The high-pressure cylinder is provided with Mayer expansion slides, and regulated by hand, by means of a wheel in the usual way; the range of cut-off being indicated on an engraved brass index plate. The cylinders are clothed with non-conducting composition, and covered with planished sheet steel, which is in every way an improvement on wood lagging. The engines are provided with a high speed governor and throttle-valve, and also with auxiliary starting-valve.

The water delivered from the main pumps passes into the accumulators, which are among the largest constructed. The rams are 20 in. in diameter, and have a stroke of 23 ft. They are each loaded with 110 tons of slag, contained in a wrought-iron cylindrical box, suspended from a crosshead on the top of the ram. The area of each ram is 314 sq. in., and the pressure being 800 lbs. on the square inch, the total load is 314 × 800 = 251,200 lbs., or a little over 112 tons. Allowing 5 per cent. to overcome the friction of the packing, etc., we have 120 tons, the extra 10 tons being supplied by the weight of the ram and the casing. One of the accumulators is loaded a little more heavily than the other, so that they rise and fall successively; the more heavily loaded actuates a stop-valve on the main steam-pipe. If the engines supply more water than is wanted, the lighter of the two rams first rises as far as it can go, the other then ascends, and when it has nearly reached the top, shuts off steam and checks the supply of water automatically. Although one accumulator is always in advance of the other, the difference of load is so small that both move at the same time. The result is that the pressure is maintained in the mains with very great regularity.

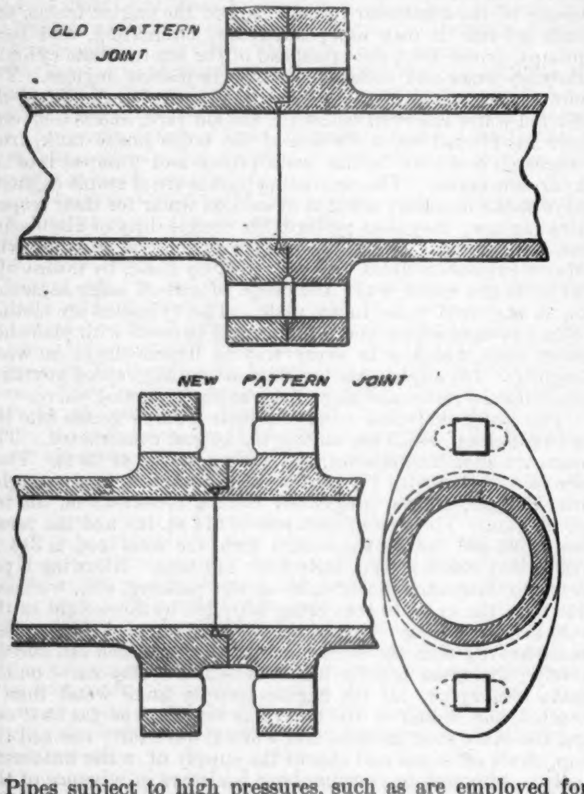
Steam is supplied by six boilers fitted with economizers and mechanical stokers. The boilers throughout are of Siemens-Martin steel, and each one consists of a top and bottom vessel connected by steel "blocks." The top vessel is 21 ft. long and 4 ft. 6 in. diameter, with flanged and dished ends. The bottom vessel is 18 ft. long, 5 ft. diameter, and is fitted with a flue, 3 ft. 9 in. diameter. The flue is composed of welded and flanged rings, connected by a tube-plate to a battery of 3 in. tubes at the back end. This flue is fastened to the front and back end plates by bolts, the joints being specially prepared. This enables the flues to be drawn out for inspection and cleaning. To facilitate the operation a rail is fixed to the shell on which the pulleys attached to the flues run. A longitudinal dome or receiver is placed on the top of the boiler to insure perfectly dry steam. The boiler being so quick a steam raiser, this dome is advisable also, on occasion, to prevent priming.

The coal when delivered at the station is discharged by a 20 cwt. hydraulic crane, which raises the coal in buckets from the lighter in the adjacent dock on to an elevated staging, from whence it is run in a truck to the coal store adjoining the fire-

room. From the coal store it is taken as required in a hopper-bottom truck, which is raised by a hydraulic lift on to an elevated roadway over the fire-room and discharged into a conveyor hopper, from whence it is carried to the several stokers as required.

The boilers and economizers together have evaporated 11.1 lbs. of water at 146 lbs. pressure from the hot well temperature with 1 lb. of Nixon's navigation coal. Combining the best results obtained on trial of the engines and boilers, the coal used per indicated horse-power works out at 1.27 lbs.

It will be readily understood that it is of the first importance that the mains in the public streets should be so constructed and laid as to be perfectly trustworthy and free from leakage. The velocity of water flowing from a free orifice with a pressure of 700 lbs. per square inch being about 320 ft. per second, a very small hole in a pipe may lead to a large escape of power. Every pipe and valve used throughout the system is tested to 2,500 lbs. per square inch before being placed on the ground, and again tested to a reduced pressure in the trenches to insure the perfect tightness of the joints. The jointing material used is gutta-percha, on the system introduced by Lord Armstrong many years ago, but the form of the flanges has been modified by Mr. Ellington so as to insure their being of even greater strength than the body of the pipe.



Pipes subject to high pressures, such as are employed for conveying water to work hydraulic machinery, are usually jointed as shown in the first of the diagrams on page 45. When such pipes are subject to excess of pressure, or when they are overstrained in the act of jointing, they generally give way right through one of the corners. By facing the flanges of the two pipes with projecting bosses of some height as indicated by the second section, and thus increasing the depth of the line along which fracture would otherwise take place, the pipes are made as strong at the jointing as in any other part.

Practically, no failures of pipes have occurred since this improvement was effected. At the present time there is no appreciable leakage on the system.

The hydraulic power is sold by meter, the charges being based on a sliding scale, commencing with a minimum charge of 25*s*. per quarter per machine, for which sum 3,000 gallons is supplied, and where the consumption is up to 500,000 gallons per quarter the charge is 2*s*. per thousand gallons. For very large consumptions the charge is still further reduced. We believe the average rate obtained by the company is about 3*s*. per thousand gallons. The principal use of the power is for intermittent work in cases where direct pressure can be employed, as, for instance, passenger elevators, cranes, presses, warehouse hoists, etc. For such purposes hydraulic power has been long recognized as being the best and most trustworthy. It is not surprising, therefore, to find that this company has secured so large a share of the lifting work of London. It has been proved more convenient and satisfactory than any private system of power supply, and the sliding scale of charges adopted by the company has enabled it to meet the requirements of both small and large consumers with profit to itself and the public. Circumstances differ so widely that it is not perhaps possible to make any general statement as to the economy of power over older systems, but in many cases proprietors of wharves have found the saving sufficient to pay the cost of the new hydraulic machinery substituted for steam or other plant in three or four years. In a great number of cases also the pumping machinery of existing hydraulic plant has been abandoned, the company's charges being found to be below the actual running expenses of the consumer's own plant. In new premises there is of course the large additional saving in the smaller outlay of capital required. The most notable instance of the economy of the public supply system is perhaps at the London Docks, where about half the power used is now taken from the company; but most of the principal railways, wharves, hotels, warehouses, and office buildings now make more or less use of the company's power. There are also a good many rotary motors at work, principally Brotherhood's well-known three-cylinder hydraulic engine. The electric current used by the Exchange Telegraph Company is obtained from a dynamo worked from the hydraulic power mains, and in addition to the hydraulic engine fitted up for it by the Hydraulic Engineering Company a few years ago, the company has recently fixed for it a Pelton wheel. Such a wheel is obviously well adapted for dynamo driving, and it is interesting to note that the difficulties of employing pressures of 700 lbs. or 800 lbs. per square inch have been overcome.

A very important use of the hydraulic power requires to be noticed—*i e.*, its application to the extinguishing of fire by means of Greathead's injector hydrant; about 100 of these hydrants are in use. Queen Anne's mansions, St. James's Park, have them on every floor. The buildings of New Scotland Yard and the National Gallery are also fitted with them, and there are a few in the streets. By the use of these hydrants a continuous fire-engine is available.

The system of hydraulic power which we have been describing is being adopted in other towns. It was first established in Hull in 1875; then came London in 1882; Liverpool followed in 1886. The system has also been established in Melbourne and Sydney. The Birmingham Corporation recently commenced to supply hydraulic power on their own account, and works have just been commenced in Manchester and Glasgow. The development of this branch of hydraulics has been almost exclusively of English origin and growth, and at the present time it may confidently be stated that nothing approaching to the installation we have been describing is to be found elsewhere. The capital outlay in London has been nearly £400,000, and the dividend paid for 1891 was 5¾ per cent.

ELECTRIC CAR LIGHTING ON THE NORTHERN RAILWAY OF FRANCE.

THE *Journal des Transports* is authority for the statement that the Northern Railway of France is about to make an application of electric lighting to the saloon cars, sleeping cars and first, second and third-class compartment cars in use upon their system. The step is to be taken after prolonged tests upon isolated cars, and it has been decided to experiment upon a larger scale with regular arrangements, devised as a result of these experiments which have been carried on between Paris and Lille.

Each car is lighted by a storage battery furnishing the current to lamps of 6, 8 and 10 candle-power, according to the class of carriage in which they are used. The arrangements are also so made that oil may be substituted for the electric lighting at a moment's notice, and that, too, without disturbing any of the electrical apparatus.

The storage batteries are sixteen in number, and are enclosed in groups of two in a small and easily handled box. These eight double batteries are suspended from the sills, and are accessible at the sides from the footboards, and are closed by doors turning down upon the footboards themselves.

Each battery is composed of nine plates, of which four are positive and five negative, contained in a small ebonite case arranged to receive 11, of which five are positive and six negative. These plates are 7¾ in. high, 4 in. wide and ¼ in. thick; each weighs 2 lbs., or, to speak more accurately, the weight

per cell is 17.6 lbs., and they have a capacity of 6⅘ ampere-hours per pound of lead. The weight of each cell, inclusive of accessories and liquid, is 28 lbs.; the two cells enclosed in the box weigh 66⅛ lbs. and the whole 16 cells 529 lbs., to which must be added 330⅞ lbs. for the casings beneath the cars. The whole battery has a minimum total capacity of 113.4 ampere-hours. The lamps are of the 30-volt type of 10 candle-power for first-class compartments, saloon cars and sleepers; of 8 candle-power for second-class compartments, and 6 candle power for third-class cars, lavatories and closets. They consume 2.9 watts to 3 watts per candle-power, and have a minimum duration of 30 hours. They are carried by a stem of cylindrical hard wood, which supports, at the same time, the lamp socket and the reflector, which is a sheet of white enamel. The apparatus is enclosed in the lantern itself in the place of the oil lamp. The wires are let into a block of hard wood set into the ceiling near the lantern opening.

The switches are enclosed in a small box at the two opposite ends of the car, and are so arranged that the lamps may be lighted or extinguished from either one without leaving the footboards and the batteries recharged without moving them from their positions. Finally the principal wires connecting the batteries with the lamps and switches have a special insulation so as to register mechanically and electrically any damage or injury from the weather. These wires run along the sills, to which they are fastened by clamps of zinc solder. When an oil is to be substituted for an electric lamp, the lantern is opened and the electric lamp with its support removed and the oil lamp put in its place. There is no need of taking any special precautions in this work.

The first cost of the apparatus has not been definitely settled as yet because only a small number of cars have been equipped. It is somewhat expensive, but the following figures may be considered to be above rather than below the probable average: First-class compartments, $145; second-class, $148; third-class, $150; and $140 for baggage vans. As we have said, this first cost has not yet been accurately determined, and the extensive experiments which have been undertaken by the company have just this very object in view. Meanwhile what has already been done permit of the expectation that the actual cost will not vary very much from the figures given even when a better light is provided

In conclusion, the duration of the light will be quite long, as the batteries can furnish about 33 hours' continuous lighting without being touched. The lamps need attention about once in 18 hours.

A PECULIAR EXHAUST NOZZLE.

A RECENTLY designed engine on the Northern Railway of France is provided with a novel exhaust nozzle, for the engravings of which we are indebted to the *Revue Générale des Chemins de Fer*. There is a bronze flap valve located beneath the regular nozzle, that may be adjusted by the engine driver in either of the two extreme positions; one permitting a free exhaust in the ordinary manner, and the other turning the steam into the pipe *t* which is placed against the inside of the stack and opens into the atmosphere. This pipe is oblong in form, as shown by the sectional cut at the bottom of the engraving. The flap may also be fixed in the intermediate position as shown.

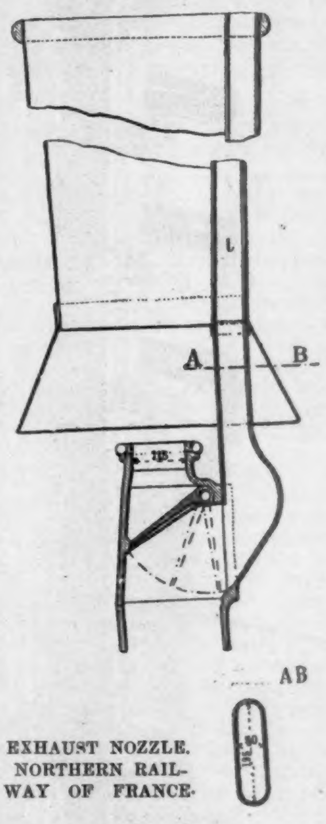
This arrangement has been adopted after a prolonged trial upon old tramway engines, whereon the tests were most satisfactory. The startings which occur with a full admission of steam into the cylinders are ordinarily too frequent for these locomotives, and the result is that with the regular exhaust the draft is excessive. The inconveniences resulting from this have entirely disappeared with this new arrangement.

EFFECT OF TURPENTINE GATHERING ON THE TIMBER OF LONGLEAF PINE.

THE following circular, No. 9, has been issued by Mr. B. E. Fernow, Chief of the Forestry Division of the Department of Agriculture, and should go far toward settling the question under dispute. Personal conversation with longleaf pine lumbermen of the South has convinced us that the statements of the circular are true, for it is the unanimous testimony of all with whom we have talked that turpentine gathering has no appreciable effect upon the timber. Still the specifications of many of our leading roads require that all yellow pine shall have been untapped. Whether they get it or no is another question.

"In Circular 8 of the Forestry Division, published about a year ago, it was stated that tests made on timbers of longleaf pine, bled or unbled, lent countenance to the belief that bled or tapped timber did not suffer in strength by virtue of the tapping. Further tests and examinations permit now the announcement without reserve that *the timber of longleaf pine is in no way affected by the tapping for turpentine.* This refers to its mechanical as well as chemical properties, and hence even the reservation that it might suffer in durability is now eliminated, and any prejudice against the use of bled timber in construction, wherever the unbled timber has been considered desirable, must fall as having no foundation in fact, being based only on vague belief, proved to be erroneous.

"It is to be hoped that this fact will be made widely known among builders, architects, and engineers who have hitherto made discrimination against bled timber, and thereby depreciated or discouraged the manufacture and impeded the sale of an article which answers all the purposes of construction and the unrestricted use of which is dictated by true economy.



EXHAUST NOZZLE. NORTHERN RAILWAY OF FRANCE.

"The basis for the statement regarding the mechanical properties is furnished by a series of tests comprising not less than 300 tests on 32 trees of this pine, bled and unbled, from various localities.

"The somewhat puzzling fact that bled timber exhibited, if anything, greater strength in the tests has been accounted for by the fact that the turpentine orchards are located mostly on sites which produce better quality timber as well as larger yield of turpentine.

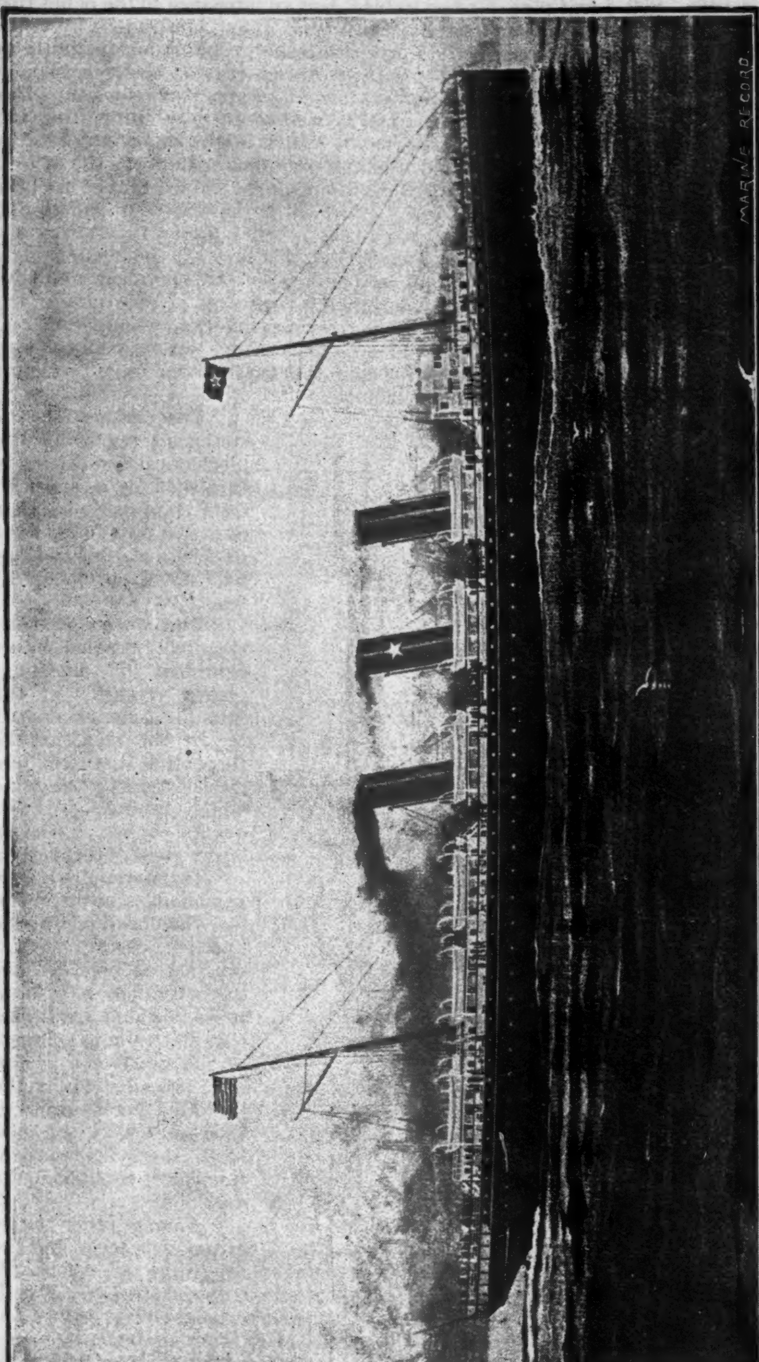
"To determine whether any changes in the chemical composition take place, a series of chemical analyses of bled and unbled timber has been made, which indicates that the resinous contents of the heartwood are in no wise affected by the bleeding, the oleoresins of the heartwood being non-fluid, the whole turpentine flow is confined to the sapwood.

"Among other interesting facts regarding the distribution of resinous contents through the tree which will be published in a separate bulletin, it appears that trees standing side by side and to all appearances in similar conditions show very varying quantities of resinous contents.

"To make sure that experience did not, if sifted down, contradict the results of these investigations, a competent agent, Mr. F. Roth, visited turpentine orchards and sawmills in the longleaf pine region. He reports that nobody was found—although it was claimed by some—able to discern any difference in the appearance of the bled and unbled timber; that in spite of consumers' specifications for unbled timber, they are almost invariably served with a mixture without finding it out; that experience in the districts where bled timber is cut and used has not sustained the claim of inferiority.

"This information is furnished in advance of the full report on the investigations in question, in order to remove as quickly as possible the unwarranted discrimination against the product of nearly one million acres of Southern pine, which are annually added to the total acreage in turpentine orchards.

"This result of authoritative investigation should be worth several million dollars to the forestry interests of the South, permitting readier use and sale for a product that



NEW PASSENGER STEAMER FOR THE NORTHERN STEAMSHIP COMPANY.

left uncut endangers the future of the forest by the destructive conflagrations to which it is specially subject."

NEW LAKE PASSENGER STEAMERS.

The Northern Steamship Company, of which J. J. Hill is President, and which is controlled by the Great Northern Railroad Company, has placed an order with the Globe Iron Works Company, Cleveland, O., for the construction of two of the speediest and largest steamers ever built on fresh water, the contract to be completed for the opening of navigation in 1894. For the accompanying engraving and the description given, we are indebted to the courtesy of the Cleveland *Marine Record.*

These vessels are to run between Buffalo and Duluth, a distance of 1,000 miles, at the rate of 20 miles an hour, thus completing an important link of the Great Northern system of transportation between New York and Boston on the east, and Puget Sound, in the State of Washington, to the west.

The engraving shows the general appearance of these steamers. Their principal hull dimensions are to be 380 ft. over all, a length never before attained on the lakes; 360 ft. keel, 44 ft. beam, and 34 ft. molded depth. The engines are to be of the vertical quadruple expansion type, and arranged in the following order: High-pressure cylinder, 25 in. diameter; first and second intermediate cylinders of 36 in. and 51½ in. respectively, and low-pressure cylinders of 74 in.; stroke of piston, 42 in.; to develop 7,000 H.P. The engines will have Joy valve-gear. The boiler power will consist of a battery of 28 Belleville boilers, to carry 225 lbs. steam pressure; independent air pumps and condenser, electric-lighting plant, patent windlass, steam steering-gear, and steam capstans and every modern appliance in the list of high-classed equipments will be furnished these steamers, which are considered as being a masterpiece in the art of lake shipbuilding.

The advantages of twin screws for vessels required to develop a high rate of speed are so manifest that they promise to soon supersede the single screw entirely; but at the present time only the finer class of boats are being fitted with the twin screws, chiefly, we presume, on account of the initial cost and space required for extra machinery. The entire lower holds of these two new steamers, however, are to be given up to the engines, boilers and fueling space, and their propeller wheels will be 13 ft. in diameter by 18 ft. pitch, supported by heavy steel brackets arranged on each side abaft the boss plates.

The cost of these two steamers is $1,100,000, or $550,000 each, and it is officially stated that they are the precursors of a fleet of six similar vessels which will make daily sailings from each end of the lake route as soon as the western terminus of the Great Northern Railroad system is established and the freight and passenger trade to Australia, China and Japan becomes developed. The Great Northern has already a fleet of six large steel freight steamers which have been engaged in the advancing lake trade between West Superior and Buffalo for the past four years, and with the advent of what will certainly be the finest passenger boats ever placed on the lakes, the passenger traffic will no doubt be largely increased.

As shown by the engraving, the new boats will resemble ocean steamers in their general appearance much more than the usual type of lake steamers.

ACCIDENTS TO WORK-PEOPLE.

The United States consul at St. Étienne has reported an abstract of the work of the International Congress, which recently met at Berne. The analyses, general treatment, and marshalling of statistics bearing on the subject of accidents to working people were scientific, skilful, and thorough. It was shown that there are 100 accidents to each 10,000 workingmen, one-half fatal and one-fourth producing permanent injuries. While Belgium, England, France, and Italy give to a certain degree, information as to accidents in mines and on railways, Switzerland published a detailed statement of all accidents reported between April 1, 1888, and March 31, 1889. In Germany, according to the Imperial Assurance office, there were in 1889, 15,970 injured by accidents, of whom 2,956, or 18.51 per cent., were killed, and 13,014, or 81.49 per cent., received injuries rendering them incapable of returning to work under three months. The classification of the fatal injuries was: Crushed under masses or objects, 801; falling, 512; machinery, 469; molten, liquid or irrespirable gases, 295; cars, carriages, etc., 236; railways, 149; weights, 130;

drowning, 117; explosives, 86; animals, 42; steam boilers, 36; tools, 30; other causes, 53; total, 2,956. There are moral and material causes for accidents, the former arising from the fault of the employers or workmen and from unforeseen causes. The latter are more difficult to determine. In France there is, at the office of the Minister of Public Works, a committee to inquire into the causes of steam-boiler explosions. In 1889 the presumed causes of such explosions were given as: Wear and tear, 17; defective condition of construction and installation, 15; want of water, 8; over-pressure, 5; defective repairs, 3; other causes, 3; total, 51.

The following statement shows the proportions of responsibility on employers and employed for the 15,970 accidents to work-people in Germany:

	Per cent.	
Accidents imputed to employers:		
Insufficiency of preventive measures	10.01	
Defective construction	7.05	
Insufficiency of rules	2.69	
		19.75
Accidents imputed to employed:		
Awkwardness, inattention, etc	10.73	
Infraction of rules	5.17	
Manifest imprudence	1.98	
Neglect of using preventive measures provided	1.76	
		19.64
Accidents where both parties were to a certain extent at fault:		
Dangers inherent in the industry	49.41	
Simultaneous negligence	7.73	
Unknown causes	3.47	
		60.61
		100.00

In most accidents the savings of the workman are inadequate to provide resources for his family, and consequently it has been the custom to resort to a special system having the object of (1) collecting individual savings under the form of subscriptions. (2) Creating a common purse with these subscriptions to cover the risks to which the workman is more or less exposed. (3) Compensating the victim of an accident according to fixed rules. The Congress studied thoroughly the question of accidents, and resolved that it was more necessary to prevent accidents than to compensate for them, as the economical transformations, the establishment of thousands of workshops, and the concentration of workmen in exceedingly narrow limits, have increased the chances of accidents, and even caused appalling catastrophes. The French and other civil codes are no longer in harmony with the needs of the workman. Accidents are daily happening, but the Civil Code provides only for those arising from the negligence of the employer, whose responsibility is often not easily established, it having been shown before the Conseil des États de la Suisse that proof of the employers being in fault failed 75 times out of 100. The new and seductive formula of the obligatory insurance of workmen has obtained many partisans, it being no longer believed that individual initiative or private associations can guarantee sufficient provision against accidents. This being agreed upon, the Congress discussed the question whether the insurance should be entirely arranged by the State or left to the free choice of private individuals or societies. The German delegates endeavored to show that the State alone could properly take in hand the defense of the working classes—the real social organization. The representatives of Anglo-Saxon and Latin countries, especially the French, maintained that it was preferable to leave to each State the liberty to organize the insurance system according to its habits. After prolonged discussion the Congress accepted unanimously the principles of obligatory insurance, leaving to each country the choice of applying it according to its customs and existing institutions.

KRUPP'S NICKEL-STEEL CANNON.

A BOARD of Austrian Army officers recently visited Krupp's works at Essen to make a special report on field artillery. During this visit, which lasted five days, the board inspected the crucible steel foundry and also the foundry where Krupp makes his nickel steel by a process which is kept secret.

The board examined fragments of a nickel-steel cannon which had been burst with a detonating shell. The fibrous character of the fractures, together with the tests to which the specimens were subjected, demonstrated that nickel steel possessed all the necessary qualities of solidity and elasticity.

Further experiments were made at the polygon at Meppen with two Krupp field guns, 3.53 in., one of which was of crucible steel, the other gun of Krupp's nickel steel. In each of these guns they placed a shell containing a charge of 6 oz. of picric acid.

The middle point of the projectile was accurately adjusted in the bore of each gun to be at a distance of 11.8 in. from the muzzle of the gun.

Upon the explosion of the shell the crucible steel gun was burst at the seat of the shell, and a number of pieces were collected weighing variously from 4 oz. to nearly 4 lbs. The nickel-steel gun remained intact, and, with the exception of an enlargement of the bore by .29 in. at the seat of the projectile, was uninjured.

They then put a shell loaded with 6.35 oz. of picric acid in the same nickel steel gun in the same position in the bore as in the former experiment. The shell was exploded in the gun and caused an enlargement of the bore at the seat of the projectile by .374 in., and also caused a longitudinal crack 3.15 in. long in the bore. Not a particle of metal was broken off from the gun.

The new metal was subsequently tested as armor plate. The plate of nickel steel, 13.66 in. thick, had previously sustained the blows of five projectiles. In this trial they fired a projectile of 6.7 in., weighing 158.4 lbs., at a distance of 132.3 yds. The projectile penetrated the plate and was recovered 1,301 yds. beyond. It made a clean hole in the plate of the size of the projectile, but did not fracture the plate. The diameter of the projectile was increased by .027 in., and its length reduced by .134 in.—*Army and Navy Journal.*

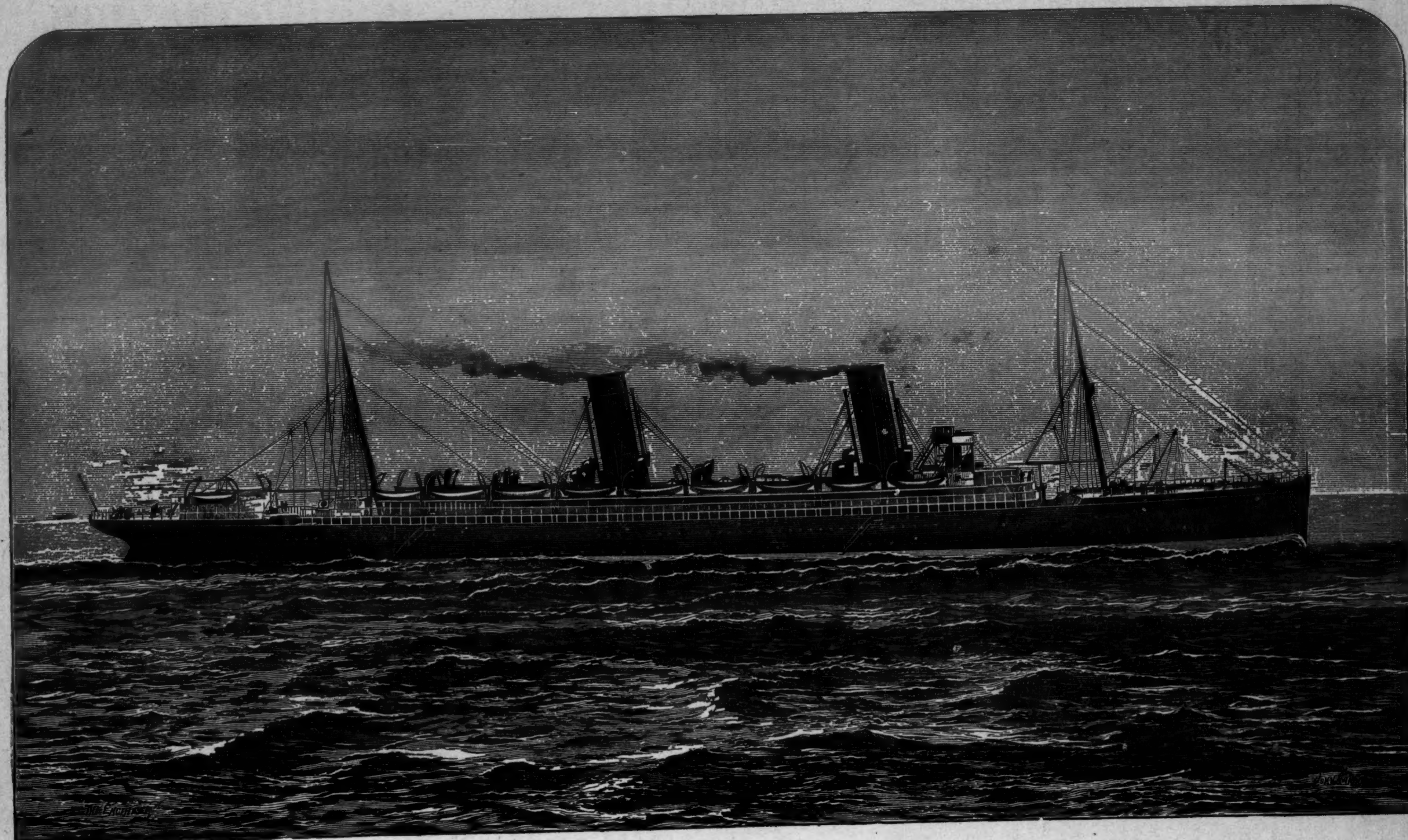
THE CUNARD COMPANY'S NEW TWIN-SCREW STEAMSHIP "CAMPANIA."

THE *Campania*, the first of the two magnificent vessels now being built by the Fairfield Company for the Cunard Line, is approaching completion in the wet dock of the builders. The engines, boilers, funnels uptakes, steam pipes, shafting, and other items which make up the total of the *Campania's* propulsive machinery were almost entirely ready for fitting on board at the date of her launch, and since that time no delay has taken place in getting this ponderous mechanism on board. A first trial, or turn, of the engines and propellers took place in the company's dock, the engines and shafting being then driven at about 25 revolutions per minute—about one-fourth of the speed at which they are intended ultimately to work.

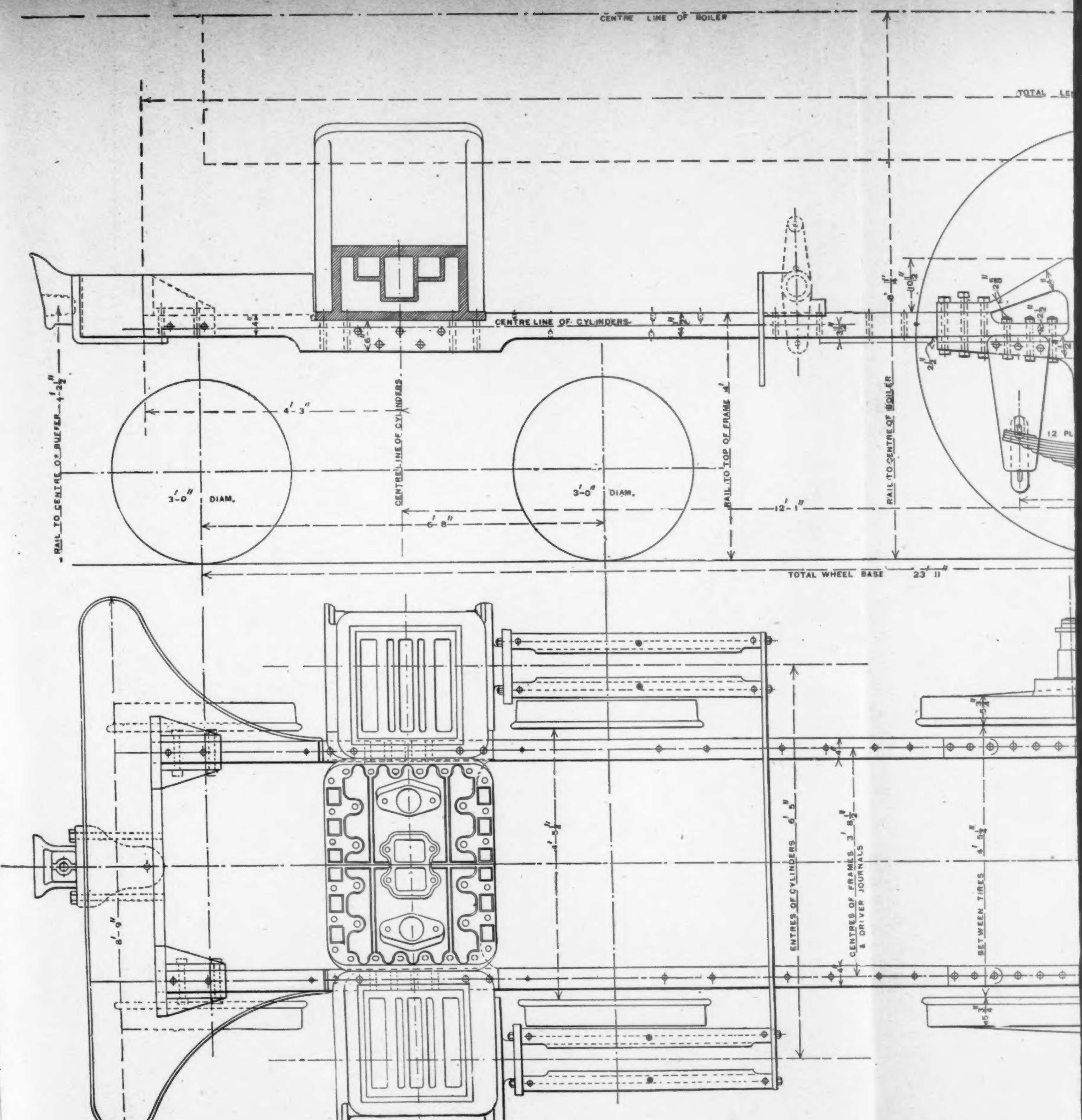
It may be safely said that the present is the twin-screw era of Atlantic navigation. It was inaugurated in 1888–89, when the four notable steamships, *City of New York*, *City of Paris*, *Majestic*, and *Teutonic*, were brought into the field, and it was soon further signalized by the introduction into the same service of the fine twin-screw vessels, built and owned by German and French firms—*e.g.*, the *Augusta Victoria* and *Fürst Bismarck*, of the Hamburg-American Line, and *La Touraine*, of the Compagnie Transatlantique. At the present time there are built and building as many as 35 twin-screw steamships of over 5,000 tons, the *Campania* making the fifteenth vessel to be produced of over 6,000 tons.

The *Campania* is for the present the longest and most capacious steamship afloat, her 600 ft. length between perpendiculars being only 80 ft. short of that of the late lamented *Great Eastern*, and her beam of 65.7 ft. being 17 ft. less than the defunct leviathan. The vessel in actual service most nearly approaching her in length is the White Star *Teutonic*, which is 566 ft. between perpendiculars, or 34 ft. less, the beam being 8 ft. narrower. The *Campania* is 73 ft. longer, but only 1 ft. 9 in. broader than the Inman Company's *City of Paris* and *City of New York*. Her length over all is 620 ft.; breadth extreme, 65 ft. 3 in.; depth to upper deck, 43 ft., and gross tonnage, about 12,500 tons. Her displacement will probably be 18,000 tons. The vessel has a straight stem and elliptic stern, top gallant forecastle and poop, with close bulwarks, all fore and aft, and erections above the upper deck consisting of two tiers of deck houses, surmounted respectively by the promenade and shade decks.

The *Campania* is fitted with two sets of the most powerful triple-expansion engines that have yet been constructed, each set capable, it is believed, of indicating from 14,000 to 15,000 H.P. These engines are fitted in two separate engine-rooms, there being a dividing center-line bulkhead between them, fitted with water-tight doors for the necessary purposes of communication. Each set of engines has five inverted cylinders—viz., two high-pressure, one intermediate-pressure, and two low-pressure cylinders; the two high-pressure being placed tandem-wise above the low-pressure ones. These are arranged to work on three cranks, set at an angle of 120° with each other. The high-pressure cylinders are each fitted



THE NEW CUNARD TWIN SCREW STEAMSHIP "CAMPANIA."

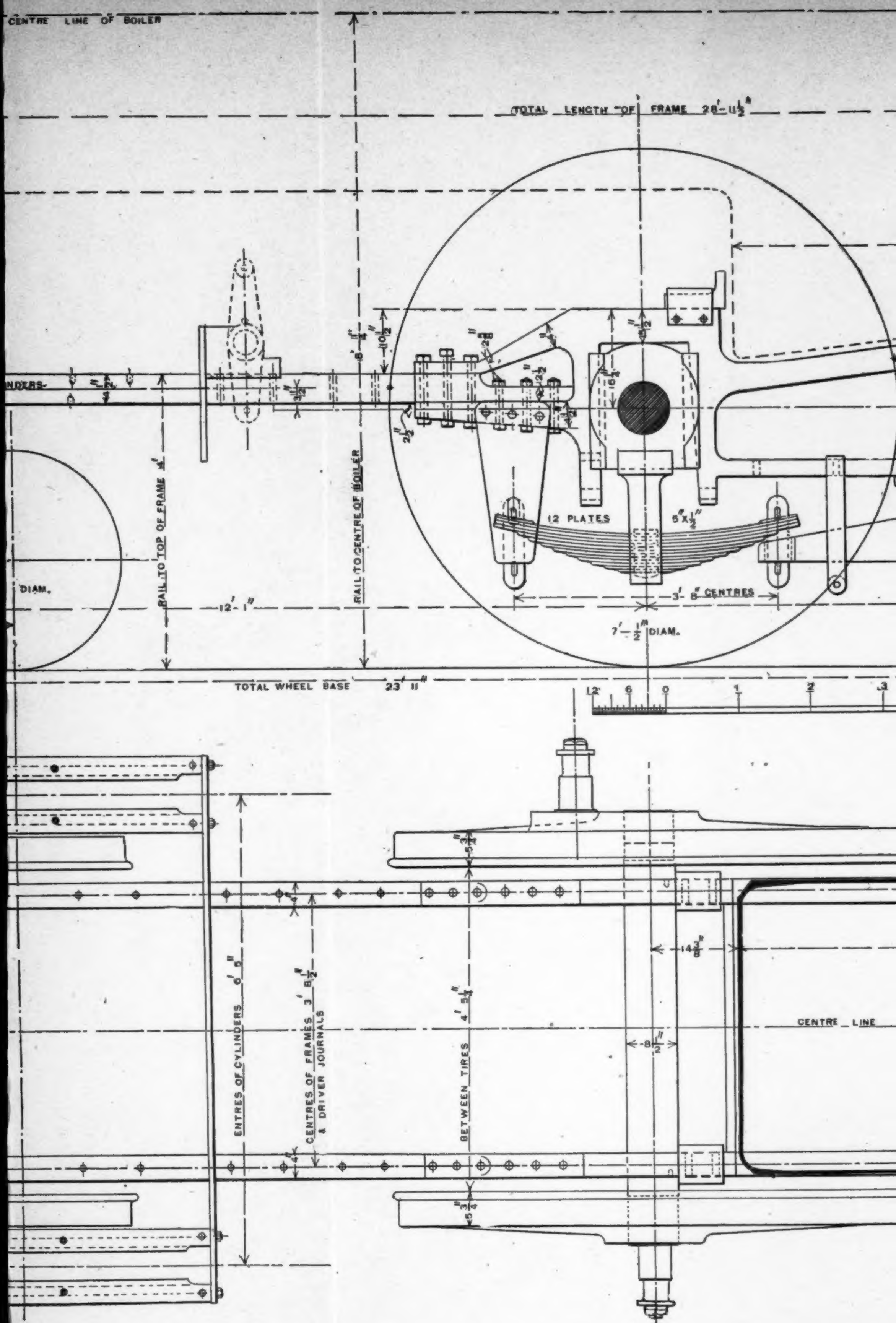


FRAMES OF AMERICAN EXPE

DESIGNED BY MR. WILLIAM BUCHANAN, SUPERINTENDENT OF MOT

BUILT BY THE SCHENECTADY LOCOMO

(*For descriptio*

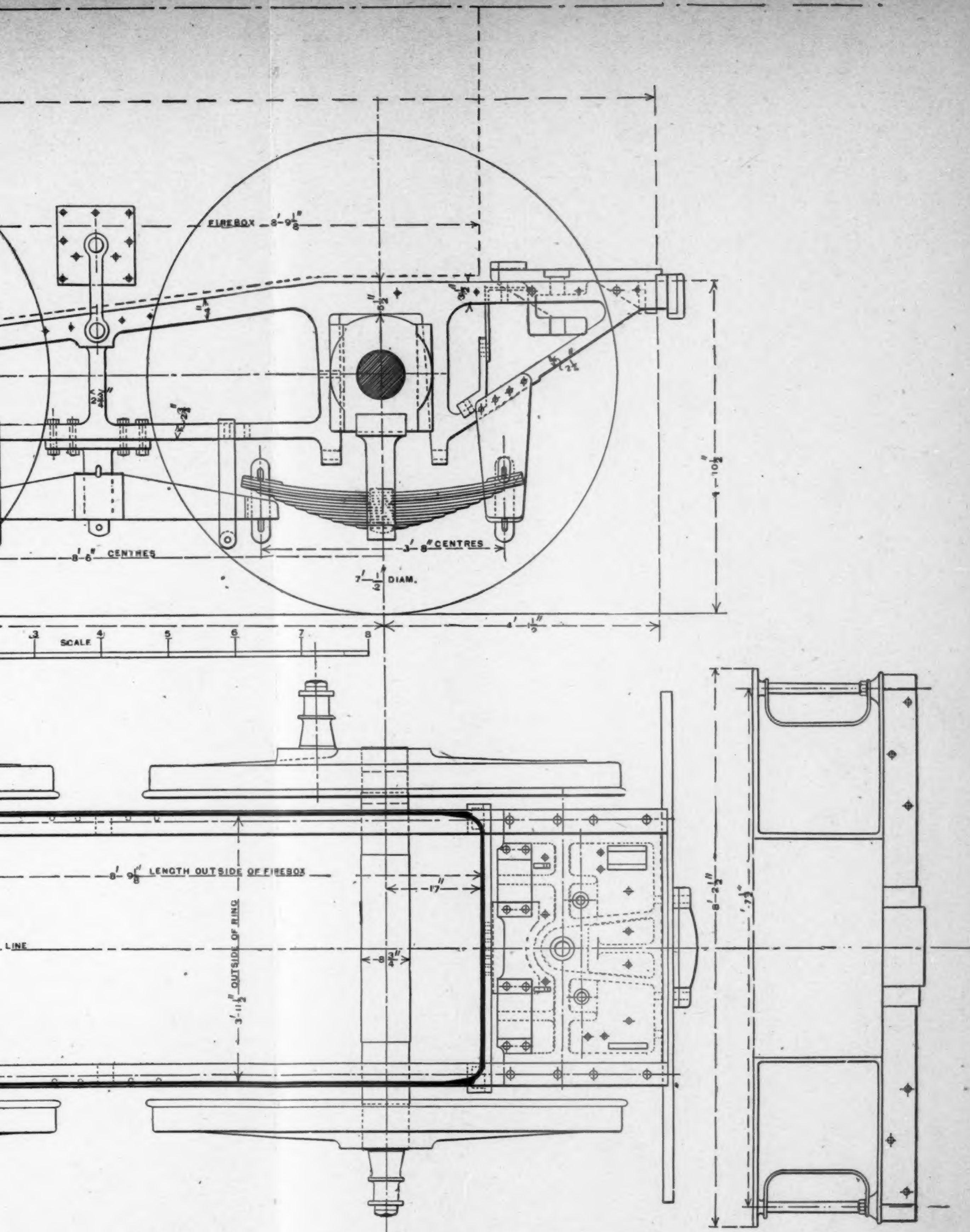


FRAMES OF AMERICAN EXPRESS PASSENGER LOCOMOTIVE

DESIGNED BY MR. WILLIAM BUCHANAN, SUPERINTENDENT OF MOTIVE POWER OF THE NEW YORK CENTRAL

BUILT BY THE SCHENECTADY LOCOMOTIVE WORKS, SCHENECTADY, NEW YORK

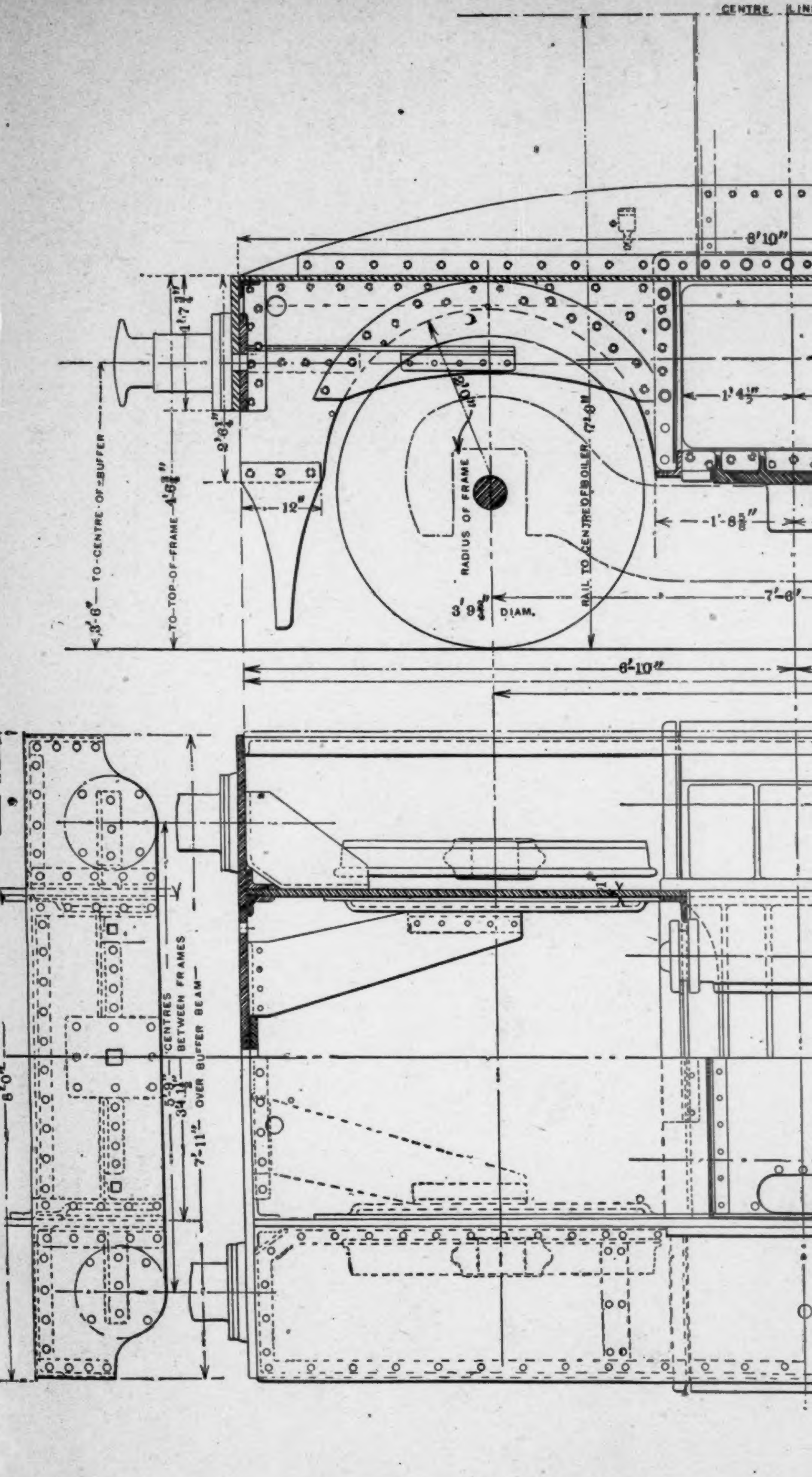
(*For description, see page* 116.)

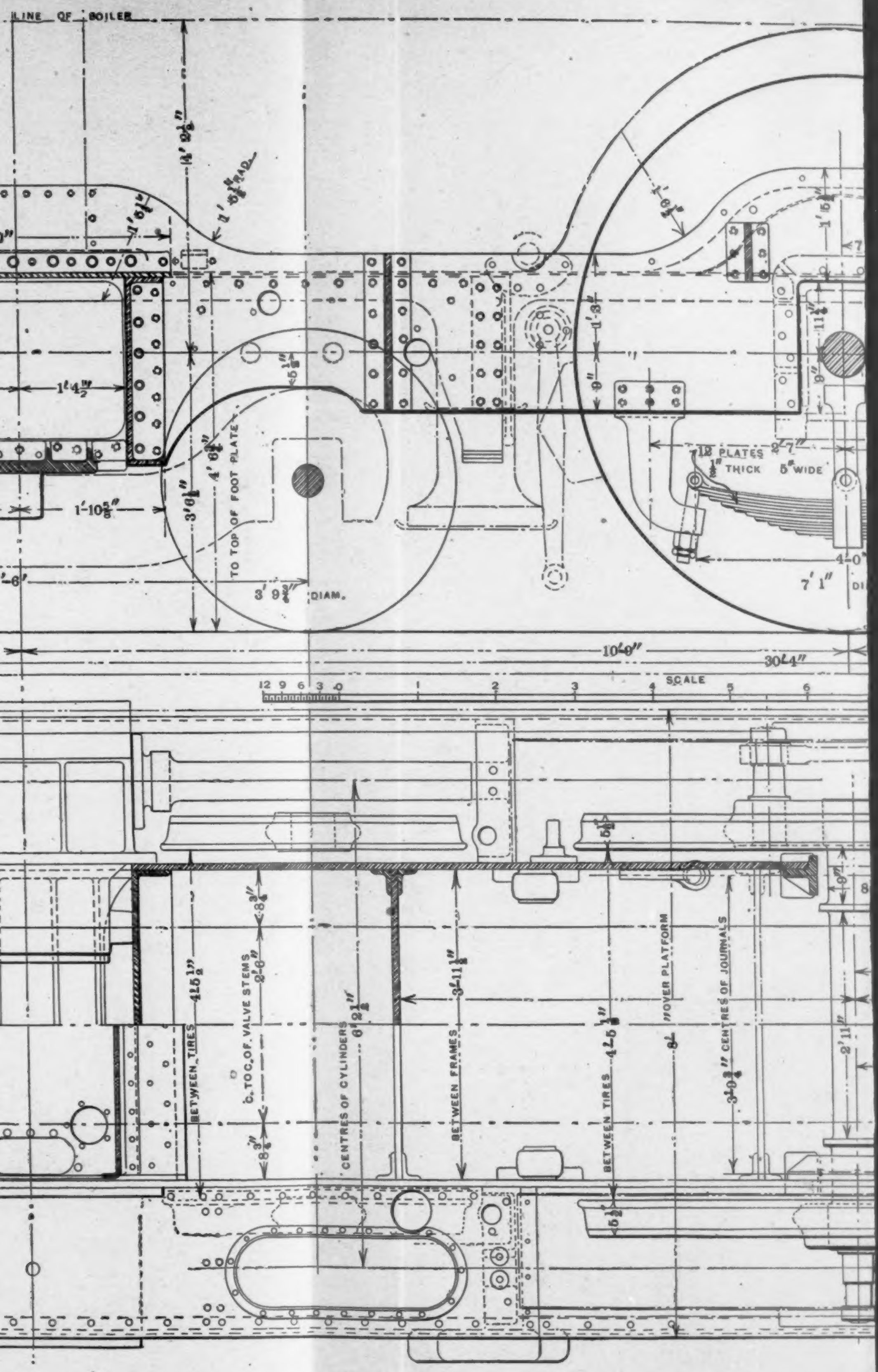


OTIVE.

ENTRAL & HUDSON RIVER RAILROAD.

YORK.


CENTRE LINE
8'10"
1'4½"
TO-CENTRE-OF-BUFFER
3'-6"
TO-TOP-OF-FRAME
12"
RADIUS OF FRAME
RAIL TO CENTRE OF BOILER
7'-6"
DIAM.
6'-10"
CENTRES
BETWEEN FRAMES
OVER BUFFER BEAM
8'-0"

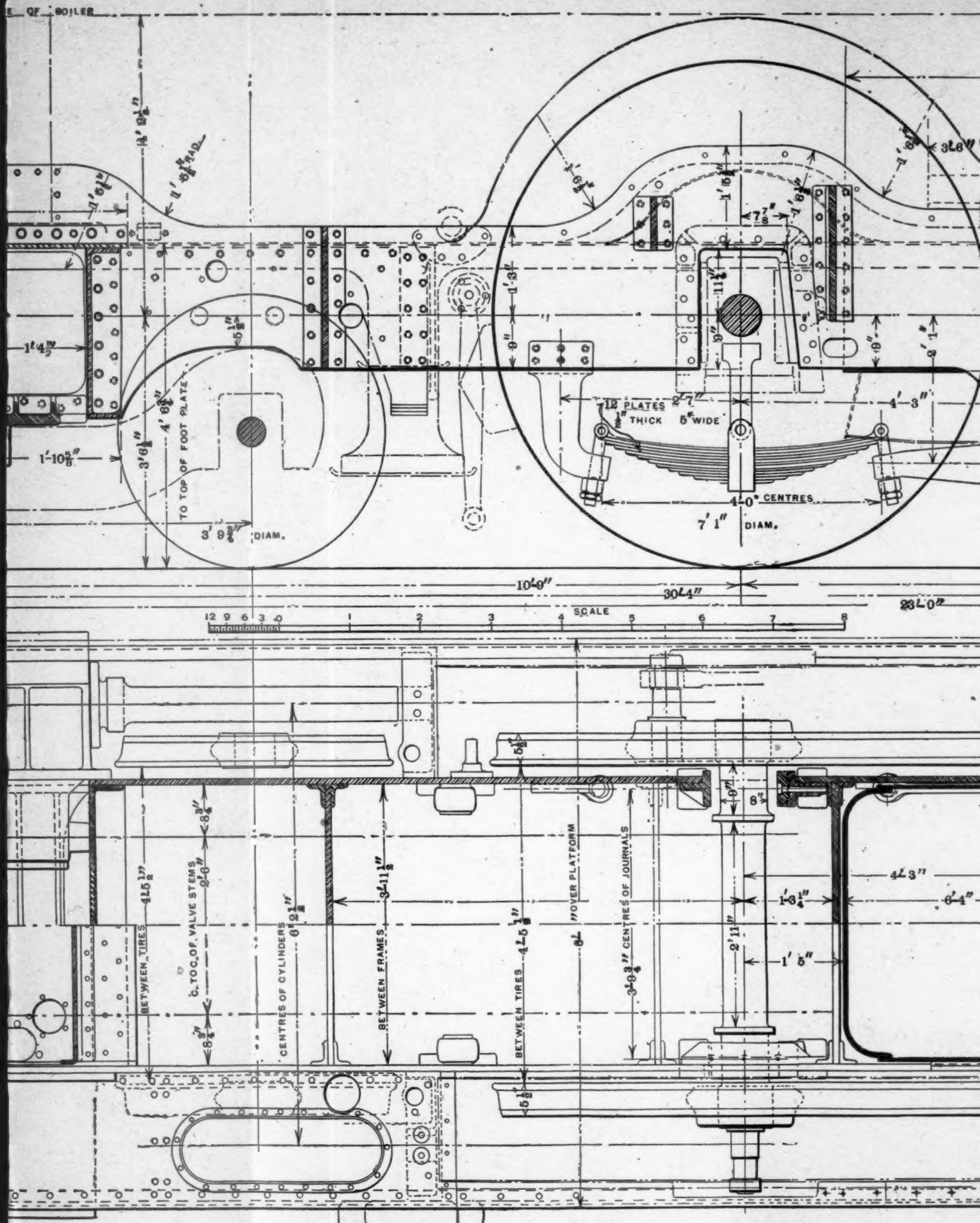


FRAMES OF ENGLISH EXPRESS PASSENGER LOCO

DESIGNED BY MR. W. ADAMS, LOCOMOTIVE SUPERINTENDENT OF THE LONDON &

BUILT AT THE NINE ELMS WORKS OF THAT COMPANY

(*For description, see page 116.*)

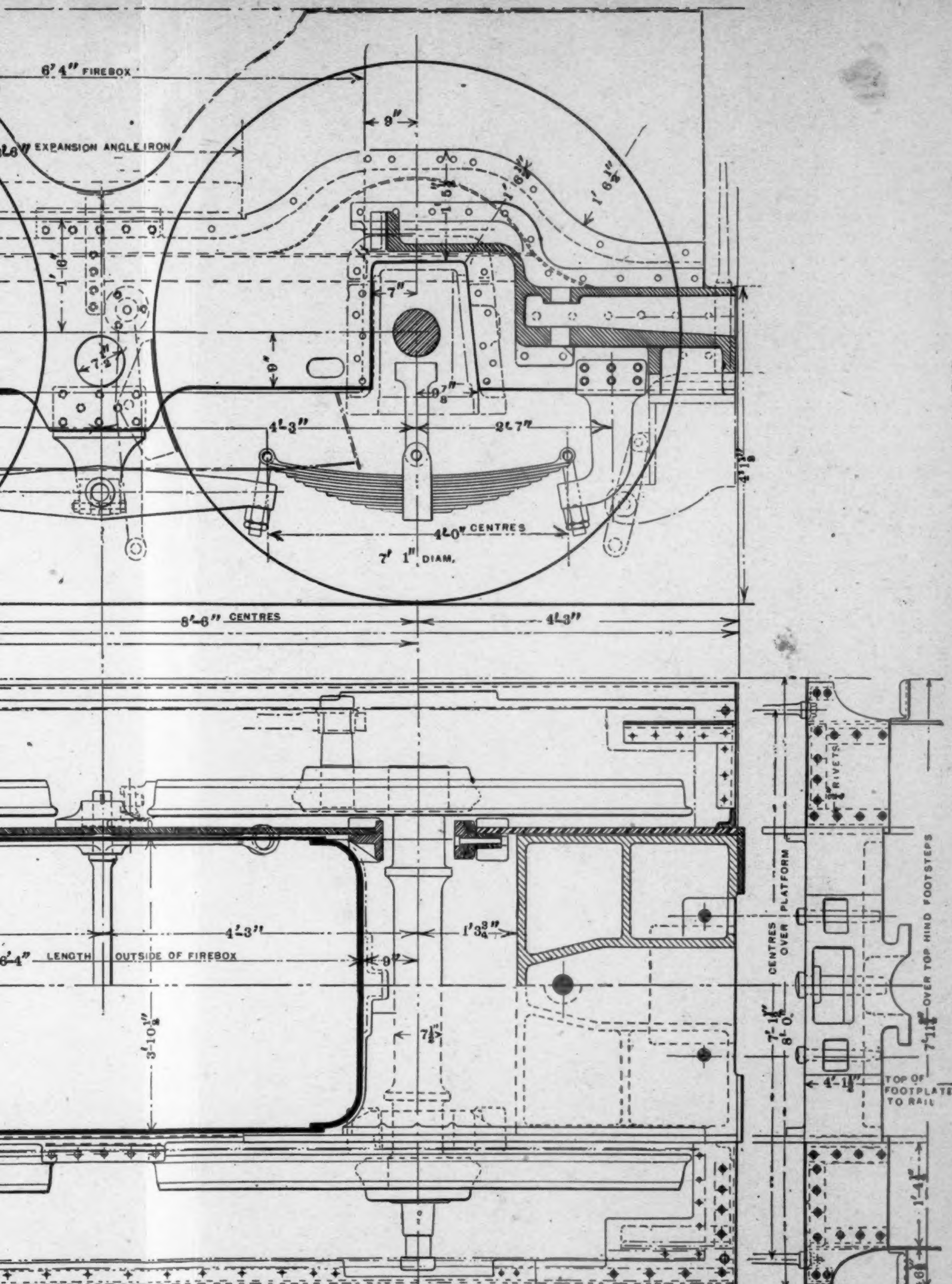


FRAMES OF ENGLISH EXPRESS PASSENGER LOCOMOTIVE.

DESIGNED BY MR. W. ADAMS, LOCOMOTIVE SUPERINTENDENT OF THE LONDON & SOUTHWESTERN RAILWAY.

BUILT AT THE NINE ELMS WORKS OF THAT COMPANY.

(*For description, see page 116.*)



6' 4" FIREBOX
9"
EXPANSION ANGLE IRON
1' 6 1/2"
1' 5"
7"
9"
4' 3"
2' 7"
9 7/8"
4' 0" CENTRES
7' 1" DIAM.
8'-6" CENTRES
4' 3"
4' 1 1/2"
4' 3"
6'-4" LENGTH OUTSIDE OF FIREBOX
9"
1' 3 3/4"
3'-10 1/2"
7 1/2"
RIVETS
CENTRES OVER PLATFORM
7'-1 1/2"
8'-0"
OVER TOP HIND FOOTSTEPS
7' 11 1/2"
4'-1 1/2"
TOP OF FOOTPLATE TO RAIL
1'-4 1/2"

AY.

with piston-valves, the intermediate and low-pressure with double piston-valves, all of which are worked by the usual double eccentrics and link-motion valve-gear. Steam from the two high-pressure cylinders exhausts into the intermediate one, which in turn exhausts into the two low-pressure cylinders, which have relieved slide-valves ; expansion taking place in three stages. The reversing engines are of the steam and hydraulic direct-acting type, and fitted with patent automatic emergency gear calculated to prevent such a disastrous breakdown of the engines as took place on board the *City of Paris*. The crank-shafts are all of the built type, in interchangeable sections. Together with the tunnel and propeller shafting, they are of mild steel, forged by Messrs. Vickers' Sons & Company, Sheffield. The condensing water is circulated through the condensers by four large centrifugal pumps, each driven by independent compound engines. These pumps may also, if required, pump water from the ship in case of damage to the hull. In the engine room are also fitted four evaporators to produce the necessary fresh water from sea water, and thereby make up the loss incurred through working, and avoid the use of salt water in the boilers. There is also a large feed-water heater, two auxiliary condensers with pumps, and all the most modern appliances to economize fuel and labor.

Steam for the main engines is generated in 12 large double-ended boilers, each having eight corrugated furnaces. The boilers are arranged in two groups of six, each group self-contained in water-tight compartments, and having a common funnel of the unprecedented diameter of 21 ft. The two funnels, it may be added, are from their lowest section 120 ft. high, or about the height of the Eddystone Light-house. There is also a large single ended boiler for supplying steam for the electric light, refrigerating, and other auxiliary machinery. In addition, a small single-ended boiler is fitted on the lower deck for supplying steam to the distilling condensers, heating pipes, etc. An elaborate system of piping is fitted throughout the ship, and connected to the various auxiliary pumps for filling and emptying the ballast tanks, pumping out bilges, pumping water on deck in case of fire, and other purposes.

Her gigantic proportions considered, it will be readily understood that the greatest care and forethought have been expended on the structural arrangements and details throughout the huge vessel. Not only has the requisite continuity of strength been maintained throughout the entire length, in ways which experience has firmly established, but structural features have been introduced which may be said to be uncommon, if not entirely new, in ship-building practice ; suggested, if not necessitated, by the conditions as to size and proportions. All scantlings have been especially arranged, and every advantage taken of the improved sections of steel now obtainable in the way of channel bars and Z bars, etc., in order to increase the strength without adding unduly to the vessel's weight. The shell plating is in lengths of 26 ft., and in some cases longer. From the keel, which is of the flat plate type, upward to about the load water-line, the plates are fitted on the lap-butt principle, which within recent years has been steadily taking the place of flush end-to-end butt-strapped joints in merchant ships, especially those intended for carrying oil in bulk. The *raison d'être* of this change doubtless lay originally in the saving of weight and of riveting thereby effected, but experience has shown that the overlapped joint, though less sightly than the flush butt, is stronger and more efficient. In the case of the *Campania* the method adopted is somewhat more elaborate and expensive than in ordinary practice, and follows closely upon the example set by Messrs. Harland & Wolff, of Belfast, in their large ships. By the method in question the shell plates are scarphed—thinned and tapered away at the ends—for the width of the seam, thus dispensing with the tapered packing pieces in the seams at the overlap. This forms a much fairer, easier made water-tight, and more sightly seam, and presents a surface to the water offering less frictional resistance. The lapped butts are all quadruple-riveted. Above the water-line the plates are fitted end to end in the usual way, and butt strapped both inside and out. The landing edges of the shell plating in the region of the sheer strakes and at the bilges are treble-riveted.

The construction of the vessel at the stern impresses one as being uncommon in other respects than that merely of immense size. Although fitted with twin screws, there is an aperture in the stern frame similar to that in a single-screw steamer. This is provided that the propellers may work freely, though they are fitted close to the center line of the ship in order to prevent damage to or from the quay walls. No struts are fitted at the stern frame to support the outer end of the shafts, as in most other twin-screw steamers. These are in the present case dispensed with, and the frames of the hull are bossed out and plated over right aft, so as to form the stern tubes. At the outer end of these, strong castings of steel, weighing about 20 tons, are fitted, extending completely across and through the structure. These serve the purpose of shaft brackets, and being in continuation of the lines of the hull, are calculated to offer the least resistance to free propulsion. What in other vessels forms the upper part of the rudder is a fixed and symmetrical part of the hull structure, the rudder proper being entirely under water. It is of the single plate type, being formed of a heavy steel casting with massive arms, between which a thick plate is fitted and riveted. This plate, which has earned some notoriety as being "made in Germany," is in one piece, and weighs about 10 tons, the whole rudder weighing about 24 tons. The cast framework of the rudder, as indeed all the heavy castings entering into the ship's structure, were supplied by the Steel Company of Scotland. Chief of these are the sternposts of the form adopted—unusual in the case of twin-screw ships. Each complete sternpost weighs about 90 tons, and consists of four pieces, which are riveted together ; in position the main post reaches a height of about 50 ft.

The bottom of the vessel is constructed on the cellular principle for water ballast ; minute water-tight subdivision being a feature in the arrangement. There are four complete tiers of beams, all of which are plated over with steel, and sheathed with wood planks, forming the upper, main, lower, and orlop decks. The last is used for cargo and refrigerating chambers, store-rooms, etc. The other decks are entirely devoted to the accommodation of passengers, with dining and social saloons, state-rooms, bath-rooms, lavatories, etc., all on a scale of magnificence unequalled. No expense is being spared on anything calculated to render traveling at sea more comfortable and enjoyable. The casings around the boiler rooms are double, the intervening space being filled with a material which is at once a non-conductor of heat and sound. The ventilation throughout, both by natural and artificial means, is very thorough. The greater number of the sidelights are fitted with an arrangement for the free admission of air, even when, during rough weather, the lights are closed. A complete system of steam heating is fitted for the comfortable warming of all the living spaces.

The electric installation on board is in keeping with the other marvelous details of the huge vessel. There are four sets of generating plant on board, each set consisting of a Siemens dynamo, coupled direct to a Belliss engine, which runs at the rate of 280 revolutions a minute, and gives an output of 42,000 watts. This is capable of supplying 1,350 16-candle-power incandescent lights—including eight large reflectors of eight lights each, for working cargo—throughout the ship, and, in addition, a powerful searchlight for facilitating the navigation of the ship into port, the picking up of moorings, and scouting in time of war. The large switchboard for controlling the lights consists of 13 sections, so arranged that each may be connected with any of the four dynamos. From these dynamos and this large switchboard there runs throughout the ship an enormous amount of wiring—reaching, in point of fact, to upward of 40 miles in length. —*Engineer*.

CHIGNECTO SHIP RAILWAY.

History and Manner of the Transportation of Ships.

The Chignecto Ship Railway, regarded in America as one of the greatest of the practicable engineering enterprises in the world to-day, seems likely to emerge triumphant from the difficulties which have overwhelmed it, and to rank by the side of the most notable achievements of the age. The ship railway is no modern device for transporting vessels. Its origin, there can be little doubt, preceded the Christian era by many centuries. So accustomed were the ancients to transporting heavy blocks of masonry large distances on rollers, that it is not to be wondered at that they applied the principle to ships where the circumstances required.

It is known that ships were transported from the Ægean Sea to the Ionian so far back as 427 years before the Christian era, and at that time it was believed that the Dioclus, for such the crude railway was called, had been in existence for over 300 years. Some of the ships carried reached the length of 150 ft. and had 18 ft. beam. The most surprising feature in connection with this method of conveyance was that it could have been accomplished without seriously straining the framing of the vessel. It was unquestioned by the ancients that the railway gave great commercial advantages to Corinth, and placed it in the front rank of maritime cities on the Peloponnesus.

With the decay of the commercial supremacy of Greece this line was abandoned, and it is not until 1438 A.D. that another application of the principle was made, and then it was for warlike purposes. In that year the Venetians, following the plans of Nicolo Sarbolo and Blaiso de Arboribus, carried 30 galleys overland from the River Adegie to Lake Garda, 1,000 oxen, assisted by windlasses on the steeper grades, furnishing the motive power. One vessel alone was lost. The renown of this exploit was so great that it came to the ears of Soleiman Pacha, who, in 1453, employed a similar expedient at the siege of Constantinople, transferring his fleet over timber ways, greased and laid on trestling and staging. By this move, which was accomplished in a single night, Soleiman avoided the chain which formed an impassable barrier across the Hellespont, and succeeded in mooring his vessels in the Golden Horn under the walls of the besieged city, which soon capitulated.

Coming to more recent times, it may be mentioned that in 1718 several vessels were conveyed from Stromstadt to Idelfal, n Sweden, by Count Emmanuel Swedenborg, then a humble engineer, who was ennobled for the achievement. In 1826 the Cornish system of ship transportation was completed. The canal boats in the Bude Canal, at Hobbacote Downs, ascend an inclined plane 900 ft. long, provided with two lines of rails terminating at each end in the canals. Here the boats, which were provided with small iron wheels, were raised by an endless chain moved by two tanks alternately filled with water and descending into deep wells. Altogether there were seven such inclines in this canal. I come next to some American enterprises of a similar character. One was the Portage Railway from Hollidaysburg to Johnstown, Pa., which was completed in 1834, to connect the canal systems of eastern and western Pennsylvania. On this road a system of gravity railways, with ten inclined planes, the large boats of the Pioneer Packet Line were carried up and down until the completion of the Pennsylvania Railway. Another portage constructed on the same principle was completed about the same time on the Morris & Essex Canal in New Jersey, and one proposed by Josiah White for the Lehigh Canal in Pennsylvania.

The scheme of Sir James Brunlees, proposed in 1860 to the Emperor of the French, to build a ship railway across the Isthmus of Suez instead of the canal, produced a good deal of excited feeling in engineering circles. It was referred by the emperor to Marshal Vaillant, then Minister of War, who, in turn, passed it over to M. de Lesseps, who naturally rejected it in favor of his own canal scheme. The proposed railway would, it was claimed, have had the advantage of greater speed, for it would have carried the vessels at the rate of 20 miles an hour, and the estimated cost was only one-seventh that of the ship canal. The railway was to have been level throughout, and the ships were to have been supported on a framing of iron resting on wheels and springs, and these again on 10 rails. In Germany, vessels of 60 tons capacity have been carried for the past 20 years from the upper portion to the lower of the Elbing Sherland Canal. Among other undertakings of the same kind proposed, or in progress, was a project submitted to the Honduras Government, to construct a ship railway across its territory from Puerto Cabellos to the Bay of Fonseca. Then some years afterward came the preparation of plans for a ship railway to overcome the cataracts of the Nile. Next in order was Captain Ead's famous scheme for the Isthmus of Tehuantepec. The ship railway in this case was to be 130 miles long between the Gulf of Mexico and the Pacific Ocean, with gradients of 50 ft. to the mile. In the Hioto Canal in Japan the expedient of transporting boats over a railway in order to avoid locks was adopted. There the installation as a whole with the employment of Pelton water-wheels, dynamos and motors, driven by the water falling from the higher level was exceedingly novel.

We now come to the Chignecto Ship Railway, commenced in 1888 and at present about three-fourths finished. That narrow neck of land between the Gulf of St. Lawrence and the Bay of Fundy known as the Isthmus of Chignecto, which connects the province of Nova Scotia with the mainland of Canada, has been a fruitful field for engineering theories. For more than 100 years schemes have been advanced for uniting these waters by means of a canal, which would enable vessels to pass through from the St. Lawrence to St. John, New Brunswick, Portland and Boston instead of proceeding by the present dangerous and circuitous route around the peninsula of Nova Scotia. Engineers employed by the governments of Canada, New Brunswick and Prince Edward's Island have time after time surveyed the proposed route, but they have all come to the conclusion that a canal, accessible at all times of the tide, would not only cost an enormous amount to build, but would involve the expenditure of large sums in repairs and maintenance. The Bay of Fundy, remarkable for the range of its tides, was found to contain vast quantities of alluvial matter, which would quickly be deposited in the locks and waterway, which would thus be filled up. There was, moreover, a difference in the tidal level between the gulf and the bay of from 17 to 23 ft., and the necessity of providing locks to overcome this difference of level would have involved a great delay in the passage of vessels. Thus it happened that the canal scheme was finally abandoned, while a proposal by Mr. Ketchum for a ship railway for the conveyance of vessels with their cargoes bodily across the isthmus, was adopted as a substitute.

Eleven years ago, just 99 years after the idea of a canal had first been mooted, the Chignecto Marine Transport Railway Company was incorporated with a share capital of £400,000, and an authorized debenture capital of £700,000. A contract for the construction of the works was entered into, but many obstacles had to be overcome before the preliminaries were finally arranged; but eventually, in September, 1888, work was commenced. Since then it has been carried on with as much dispatch as possible. It was expected that the whole undertaking would have been completed in the autumn of 1891, but there were unexpected delays, and the company became embarrassed. This was not the result of extravagant expenditure or incompetent administration.

With regard to the character of the works, we may say that a basin for vessels is being constructed at the Bay of Fundy end 500 ft. long, 300 ft. wide, with a gate 60 ft. wide and 30 ft. high, to enclose the water when the tide is out. At the inner end of this basin there is to be a lifting dock 230 ft. × 60 ft. of first-class masonry. The dock will contain 20 hydraulic presses for lifting vessels with their cargoes a height of 40 ft. Vessels will be brought in if the tide permits and admitted to the dock. They will afterward be floated into position between the hydraulic presses, and immediately over what is termed a "gridiron" and cradle sunk to the bottom of the dock. When a vessel is in her proper position the gridiron and cradle will be gently raised to her bottom. The gridiron with the vessel and cradle will be lifted by hydraulic lifts until the rails supporting them are brought up to the level of those on the railway. Vessel and cradle, resting on wheels, will then be hauled off by a hydraulic apparatus to the railway line. The extreme weight which it is proposed to provide machinery to lift is 3,500 tons, including gridiron, cradle, and a loaded vessel of 2,000 tons displacement, or 1,000 tons register.

A double track railway, 17 miles long, in a perfectly straight line, and almost on a dead level, the heaviest gradient being 1 in 500, is being laid. The rails are of steel, 110 lbs. to the yard. The vessel will be carried on the rails by the same cradle which received her in the lifting dock. It will be carried on a large number of wheels so that the weight of the load will be well distributed, each wheel sustaining but a small portion of the burden. Vessel and cradle will be drawn by locomotives, one on each track, which are calculated to move the load with ease at the rate of 10 miles an hour.

When transported to the other end of the railway, vessel and cradle will be placed on another hydraulic lift while the locomotives are shunted out of the way. It will then be only necessary to lower the vessel to a sufficient depth to enable it to float away, the time occupied in raising, transporting and lowering the vessels will, it is computed, be about two hours. Sufficient rolling stock and transversers will be provided to enable the vessels to be carried by rail at short intervals.

The general prospects of the undertaking, from a commercial point of view, are most satisfactory. The coasting trade round Nova Scotia represents in round figures more than 12,000,000 tons a year, while the annual increase is estimated at 500,000 tons. The number of vessels leaving ports in the Gulf of St. Lawrence, Prince Edward's Island, and the Bay of Fundy, in the year ended June, 1890, was 70,000. It is believed that of this immense trade the Chignecto Ship Railway will receive the largest share. Had the utility, as well as the practicability of the enterprise not been fully demonstrated, the Government of Canada would never have committed itself to the subsidy. It is to be hoped that the Chignecto Marine Transport Company may achieve the success which an undertaking so useful and so important deserves.—*Transport.*

THE MOTION OF FLOWING WATER.

A CORRESPONDENT of *Indian Engineering* calls attention to the peculiar spiral movement of flowing water. He writes: "This phenomenon was noticed by me *in a large deltaic river* on which I was deputed to take flood observations in 1890, and I then made several experiments with a view to drafting

and publishing some formulæ regarding it, as it appeared very remarkable that it should have been so long ignored. And I would point out that this spiral motion occurs *in every channel.* When the stream is wide, or when its depth is very small compared with its width, the water divides into a series of spirals —*between* which silt is deposited. In such cases the motion of the riparian spirals is often such that floating matter is cast off on the sides, instead of being drawn into the center of the stream, and then the channel is silting on its banks. These different movements all bear intimate relations to the mass and shape of the water, the slope and resistance of the soil, etc., and afford great scope for mathematical determination, especially with regard to the neutral condition when the twist of the spirals is being changed and their action is a minimum. The knowledge of these movements is also of great value, not only for engineering works, but also for saving life, as when a man falls overboard it enables one to go to the right place to look for him, and ignorance of this fact explains why so many cases occur of persons falling into a stream and never being seen to rise again.

"The phenomenon, moreover, is universal, and occurs not only in rivers and channels, but also *in oceanic currents,* and even in astronomical nebular, the spiral forms of which it beautifully explains."

FOUR-THOUSAND-TON HYDRAULIC FORGING PRESS.

The Bochum works, in Germany, employ hydraulic presses on a large scale for forging steel ingots, the most powerful being capable of exerting a pressure of 4,000 tons. The machine has a central piston of two different diameters, the lower part being 36.6 in. and the upper 20.87 in., so that it is possible, with a water pressure of 9,000 lbs. per square inch, to secure the pressures of 1,300, 2,700 and 4,000 tons respectively. The stroke of the piston is 3.28 ft., but can be varied at will. The return stroke of the main piston is accomplished by means of two other pistons of 10.24 in. diameter worked by a water pressure of 750 lbs. per square inch. These pistons also serve as guides to the first-mentioned one. The whole machine is made of cast steel. The main cross-head, which is in two pieces, weighs 64 tons; the cylinder weighed 57 tons in the rough and 35 tons finished.

The machine is operated by a valve which is moveable by hand-lever, whose total displacement is but 23⅝ in., and which only requires an exertion of 4 4 lbs. for its manipulation, as it is only subjected to a pressure of 750 lbs. per square inch, this valve sends the water under this pressure to the pistons, which act as valves for admission and exhaust. The stroke of this valve may be divided into three parts: the first opens the exhaust; the second the admission of water at 750 lbs. pressure, and the third that of water at 9,000 lbs. pressure; this last only occurring after the head of the press has come in contact with the ingot to be forged; an arrangement that results in great economy of power.

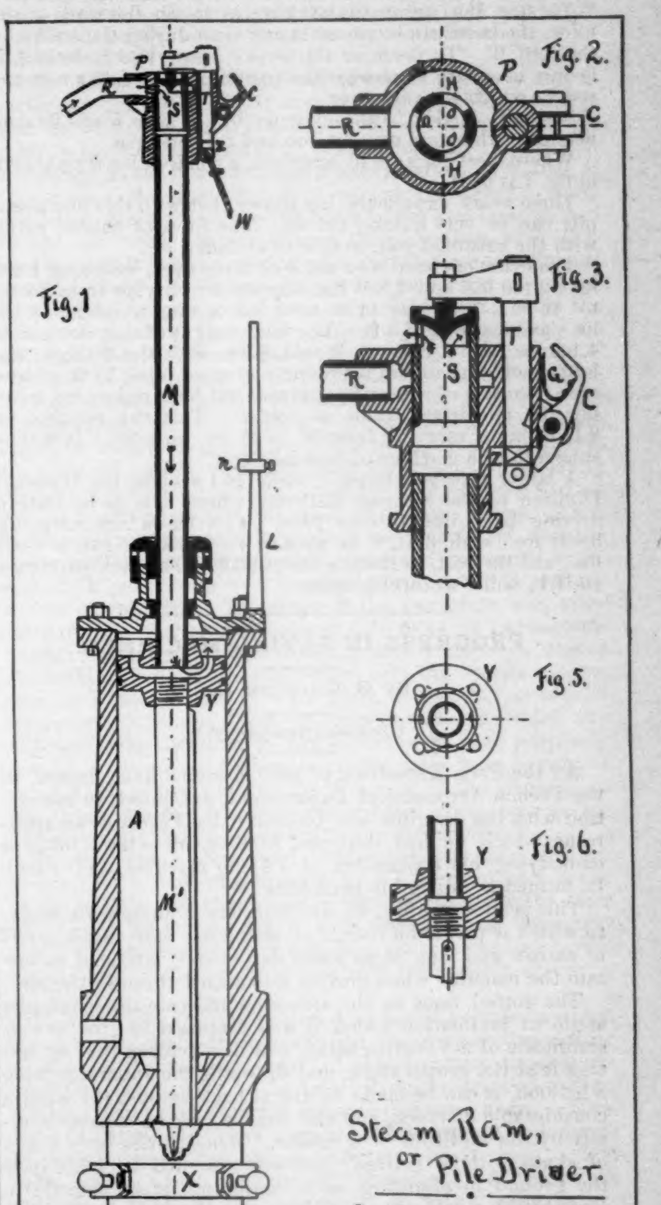
The pressure of 4,000 tons is obtained by a steam pump with two cylinders, each 30 in. in diameter and 47 in. stroke, making 30 strokes per minute. These pumps deliver under a compressed air accumulator whose plunger is 19⅝ in. in diameter, and has a stroke of 8 ft. 10½ in. The low-pressure water is furnished by a two-cylinder pump, whose cylinders are 18 in. in diameter and 2 ft. 3½ in. stroke, delivering under a weighted accumulator whose plunger is 21 in. in diameter and has a stroke of 9 ft. 10 in. All of these machines, including the accumulators, are in duplicate, to avoid delays due to possible accidents. The press is located in the center of a circular workshop 108 ft. in diameter. Its top serves as the pivot for a radial crane having a capacity of 275 tons, with the outer end of its jib carried upon a circular track. The furnaces are placed about the walls in two tiers, and are provided with various lifting appliances worked by an accumulator giving a pressure of 750 lbs. per square inch.—*Moniteur Industrielle.*

A RUSSIAN STEAM PILE-DRIVER.

The accompanying illustrations show a new steam ram or pile-driver, devised by Mr. S. Arcish, C.E., of Moscow, Russia. Fig. 1 is a longitudinal section; figs. 2 and 3 show the steam chest and valve on a larger scale; fig. 4 is a side elevation; the remaining figures show various details. It is a simple and cheap contrivance.

A very heavy cast-iron cylinder, *A*, forms the ram, and is guided in its upward and downward motion by two rods, *M* and *M'*, which are fastened to the piston *Y*. The rod *M'* has at its lower end a sharp point which is driven into the top of the pile; the latter is held in place between the upright posts of the pile-driver by the collar *X*, which is secured as shown in figs. 1, 4 and 8. The upper rod is held by the collar *X'*, figs. 4 and 9, so that the whole is supported by the pile and can move only as guided by the posts *N N*, fig. 4.

The upper rod *M* is hollow, and steam passes through it to and from the cylinder. The steam chest, as shown in figs. 1, 2 and 3, consists of a hollow cylinder, *P*, into which the upper end of the rod *M* is screwed. The steam is brought to it through the pipe *R* and passes through the annular channel shown in figs. 2 and 3, to the three openings *O O O* of the circular valve *S*. This valve is connected by an arm with the rod *T*, which moves up and down through a circular hole in a lug cast on the steam-chest. On this lug is placed a catch, *C*, held



Steam Ram, or Pile Driver.
S. Arcish, Moscow, Russia.

by a pin; this catch is kept out by the spring *G* in a position where it engages in recesses made in the rod *T*.

The operation of the ram is as follows: When it has been secured in place, and the operator wishes to begin, the valve *S* is drawn down into the position shown in fig. 1. Steam enters the valve through the annular channel, passes down through the pipe *M* into the cylinder *A* above the piston, and raises the cylinder until the lug *n* on the rod *L* strikes the catch *C*, throws it back, and frees the rod *T*. The valve will then at once rise into the position shown in fig. 3, leaving a clear opening for the exhaust, and closing the annular steam-port, and the ram will fall on the head of the pile. As the

ram falls, the catch *C* being no longer held up by the collar *n*, will permit the valve to fall back into its first position, and steam will again be admitted to raise the ram. It will be seen that the piston *Y* remains stationary, the cylinder *A* moving up and down. The pile receives the blows of the ram, and the whole machine gradually descends with it, being kept upright and guided by the posts *N N*.

When the pile is driven nearly to the limit, and will move but slightly under each blow of the ram, the slide-valve will not move quite far enough to admit the steam; it must then be operated by the cord *W*. This is not difficult, however, and a practised operator can do it without decreasing the number of blows, which is usually about 40 per minute.

To stop the automatic working or lessen the force of the blow, the ports can be closed at any time during the stroke by the cord *W*. To decrease the stroke, when that is desired, it is only necessary to change the position of the collar *n* on the rod *L*, which is easily done.

Steam is carried to the cylinder by the pipe *R* and its connections, which are usually iron and rubber pipes.

Where sheet piles are to be driven, a collar of the form shown in fig. 7 is used.

Three years' experience has shown that with this machine a pile can be very quickly driven. The time, of course, varies with the nature of soil, weight of cylinder, etc.

The cylinders have been made of three sizes, weighing 1,800 lbs., 2,160 lbs. and 2,880 lbs., the stroke varying from 36 in. to 42 in. The size most used has a ram weighing 2,160 lbs., and a stroke of 3 ft The total weight of this machine is 4,100 lbs., and it costs, in Russia, $500, with the fittings; the latter including collars for round and sheet piles, 70 ft. of iron pipe, two sets of rubber joint-pipes, and four rollers for moving the pile-driver frame as needed. This size requires an 8-H.P. boiler carrying from 50 to 60 lbs. pressure. It is thus shown to be a machine of moderate cost.

A larger type was recently made and sent to the Oussouri Division of the Siberian Railroad, where it is to be used in driving large iron tubular piles. This has a ram weighing 3,000 lbs., with 3 ft. 6 in. stroke; the total weight is 4,800 lbs., and the cost, in Russia, about $600. This ram requires a 10-H.P. boiler to furnish steam.

PROGRESS IN FLYING MACHINES.

By O. Chanute, C.E.

(*Continued from page 86.*)

At the Paris Exposition of 1889, Commandant *Renard*, of the French Aeronautical Department, exhibited, in connection with the dirigible war balloon "La France," an apparatus which he had designed some years before (1873) as embodying his conception of a flying machine, and which he termed a "dirigible parachute."

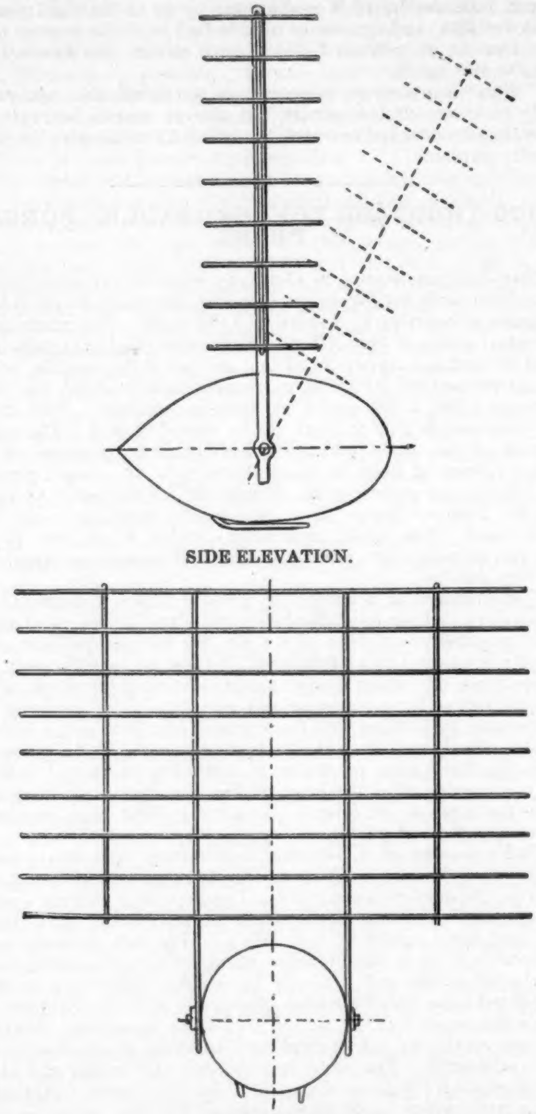
This is shown in fig. 64, and consists in an oviform body, to which is pivoted a couple of standards carrying a series of narrow and long superposed flat blades, intended to sustain the machine when gliding downward through the air.

The dotted lines in the side view indicate the maximum angle of inclination which it was proposed to give to this similitude of a Venetian blind, and it is evident that by setting it at the proper angle, and dropping the apparatus from a balloon, it can be made to travel back against the wind a considerable distance, and also that it may be steered laterally by the addition of a rudder. Beneath the body a sort of skate will be noticed, probably intended to glide over the ground in alighting, or in obtaining initial velocity to rise should a motor be applied; but the French War Department is reticent concerning its experiments in aerial navigation, and the writer has been unable to gather any information concerning the working of this apparatus.

It will be noted that Commandant *Renard* proposed to equip this machine with flat blades, thus conforming to the predilection in favor of plane surfaces exhibited by most of the experimenters with aeroplanes already noticed except Captain *Le Bris* and M. *Goupil*, who took a different view as to the best shapes to employ. In point of fact, as already intimated, those who have succeeded in the air, the true experts in gliding, the soaring birds, do not perform their evolutions with plane surfaces. Their wings are more or less convex on top and concave beneath, and are warped surfaces of complicated outlines. It is true that in many cases they do not differ greatly from planes, and the mind of man so strongly tends to the simplification of complicated shapes, that most inventors have assumed that the effect on the air will be practically the same.

Flight is possible with flat planes, as witness the butterfly, the dragon fly, and insects generally, but such creatures are endowed with greater relative power, as already explained; and, moreover, the elasticity of their wings produces change of shape under action. In the case of the birds, although the outer ends of the feathers are elastic, yet the wing is stiffer as a whole, and the curved surfaces may prove more efficient than planes in obtaining support from the air.

This view seems to have prevailed with Mr. *H. F. Phillips*, for he patented, in 1884, a whole series of curved shapes,



SIDE ELEVATION.

END ELEVATION.

Fig. 64.—RENARD—1889.

intended to be used in conjunction with suitable propelling apparatus for raising and supporting an aerial machine in the air. These shapes were to be utilized in a set of narrow blades arranged at suitable distances apart; the idea being to deflect upward the current of air coming into contact with their forward edges when under motion, so as to cause a partial vacuum over a portion of the upper surface of the blade, and thus to increase the supporting effect of the air pressure below the blade.

These shapes were the result of a series of experiments tried by Mr. *Phillips* in artificial currents of air, produced by induction from a steam jet in a wooden trunk or conduit, and described in London *Engineering* in its issue of August 14, 1885.

A cross section of the shapes patented will be found on fig. 65, Nos. 1–8. The following table gives the results observed, the last column having been added by myself:

PHILLIPS'S EXPERIMENTS ON SHAPES.

Description of Form.	Speed of Air Curr'nt. Feet per Second.	Dimensions of Forms—Inches.	Lift Ounces.	Thrust Ounces.	Feet Pounds per Pound.
Plane....	39	16 × 5	9	2.	8.67
Shape 1........	60	16 × 1.25	9	0.87	5.80
" 2........	48	16 × 3	9	0.87	4.64
" 3........	44	16 × 3	9	0.87	4.25
" 4........	44	16 × 5	9	0.87	4.25
" 5........	39	16 × 5	9	0.87	3.77
" 6........	27	16 × 5	9	2.25	6.75
Rook's Wing...	39	0.5 sq. ft.	8	1.00	4.87

The intent of these experiments seems to have been to ascertain the speed of current required to sustain various forms and areas of surfaces, carrying the same weight in a soaring attitude. For this purpose they were exposed to the varying current with their long edges transversely thereto, and they were loaded with a weight applied one-third of the width back from the forward edge, which point was thought to be the center of pressure. These shapes were swung by two wires attached to their front edges, and when they assumed a soaring attitude in the velocity of current required to sustain the weight, the "thrust" or drift was then measured.

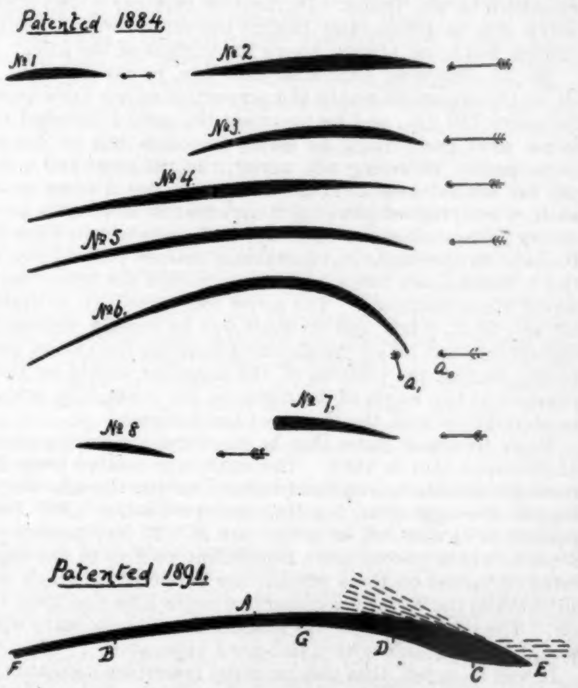


Fig. 65.—PHILLIPS—1884-1891.

The most efficient shape is, of course, that which requires the least expenditure of power, or the smallest number of foot-pounds per pound of weight to keep it afloat, and this is seen to be shape No. 5, which soared with 3.77 foot-pounds per pound, or at the rate of 146 lbs. sustained per horse power, while the flat plane absorbed more than twice as much power.

The comparison would have been more satisfactory if the soaring angles of incidence had been stated. This is given for the plane only as having been 15° by measurement. This agrees fairly well with calculation; for if the "thrust" is to the "lift" as the tangent of the angle of incidence, then we have $\frac{2}{9} = 0.222 =$ *tang.* 12° 32′. But all the results obtained were probably somewhat vitiated by assuming that the center of pressure was uniformly one-third of the distance back from the front edge, and therefore applying the load at that point.

We have already seen that this center of pressure varies with the angle of incidence in accordance with Joëssel's law, and the load should have been attached accordingly. If, for instance, the possible soaring angle were 4°, we should have for the position of the center of pressure, back from the front edge, a distance of $0.2 + 0.3$ *sin.* $4° = 0.22$ per cent. So that it seems probable that if its load had been applied at 22 per cent. instead of 0.33 per cent. back from the front edge, the flat plane would have soared at a flatter angle than 15°, and would have shown less "thrust," because the effect of placing the weight so far back was to tilt the plane unduly, and thus to increase both the angle of incidence and the thrust.

It is not known whether Joëssel's formula applies to curved surfaces; but be this as it may, it is reasonable to believe that it would be but little modified, so that perhaps the error in locating the center of pressure operated to the disadvantage of the curved forms nearly as much as to that of the plane. We may, therefore, accept the general statement that greater weights per horse power can be sustained in the air with concavo-convex surfaces than with flat-planes; but it seems very desirable that further experiments should be made, for it is quite possible that, in consequence of the loading of the blades at a point differing from the center of pressure, the shapes patented by Mr. *Phillips* are not absolutely the most efficient forms.

It will be interesting, in this connection, to note how these various shapes behaved. It was found that in order to get the maximum efficiency from any given surface, the greatest depth of hollow should be one-third of the total width from the forward leading edge, and that the amount of concavity of the lower surface and the convexity of the upper surface should bear a relation to the speed of the air current. Thus in shapes 1 and 2 the under surface was nearly flat, and the upper curvature not great, while speeds of current of 60 ft. and 48 ft. per second were required respectively to produce a soaring attitude. In shape 3 the curvature was more marked, and the required speed fell to 44 ft. per second. Shapes 4 and 5 were made broader, with a moderate degree of curvature both above and below, and the speeds of current to produce soaring were 44 ft. and 39 ft. per second respectively. Shape 6 was an extreme case, in which the distinguishing features of the experiments were purposely carried to excess; for when impinged upon by a current of air of 27 ft. per second in the direction of the arrow a_0, it was seen (by a fine attached ribbon) that there was an induced current flowing outward in the direction *a*.

Shapes 7 and 8 were used to demonstrate that the impinging air is deflected upward by the forward part of the upper surface, and that a partial vacuum results in the after part; they were not loaded with weights, and when exposed to a current of air of sufficient velocity, coming in the direction of the arrow, they rose into the position shown in the figure.

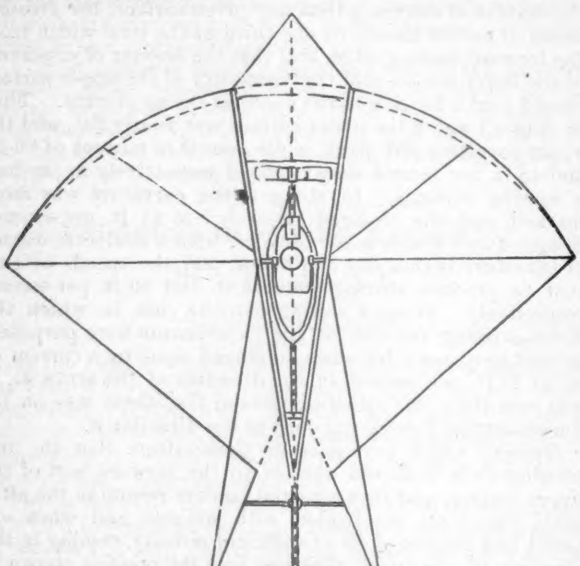
In 1890 Mr. *Phillips* patented an aerial vehicle in which these curved surfaces were applied to an apparatus similar to the "dirigible parachute" of Commandant *Renard*, except that there were to be two (or more) series of curved blades behind each other at suitable distances apart. They were to be attached to an elongated body, which he indicated might be of fish shape, and, say, 30 ft. long. The cross-blades, which he termed "sustainers," might be 15 ft. long, 6 in. wide and 2 in. apart, so many being superposed as to furnish the required supporting air surface. Each set of "sustainers" was to be held in place by a number of vertical bars of angular form, so as to offer the least resistance to the air.

The propelling power was not indicated specifically, save the general statement that it should be "suitable," but a rudder was located at the top of the front series of curved blades, being affixed to a spindle bar terminating below (at the body) with a lever arm. A shifting weight was also provided, capable of being moved across the body, transversely to its line of motion, in order, when moved to either side, not only to depress it, but, by the resistance of the air acting on the surface of that weight, to check forward motion on that side, and thus cause the machine to describe the curve required.

The patent drawings show the vertical standards carrying the blades as being rigidly attached to the body instead of being pivoted thereto, as in the case of Commandant *Renard's* device, and hence the angle of incidence of the machine could not be conveniently varied in order to rise or to descend ; but it is probable that Mr. *Phillips* has long since remedied this defect, for he is understood to have been continuously experimenting, although the results attained have not as yet been published.

He apparently concluded that he had not developed the best shape in 1884, for he patented, in 1891, the form shown at the bottom of fig. 65. In this, the upper side *A* of the blade was made convex, as formerly, but the after portion of the lower side of the blade was made concave, as shown at *B*, while the curvature of the forward portion of this lower side was in the form of a reverse curve consisting of a convex curve, *C*, at the forward edge, followed by a concave curve, *D*. He states in his patent :

"The particles of air struck by the convex upper surface *A* at the point *E* are deflected upward, as indicated by the dotted lines, thereby causing a partial vacuum over the greater portion of the upper surface. The particles of air under the point *E* follow the lower convex and concave surface *C D* until they arrive at about the point *G*, where they are brought to rest. From this point *G* the particles of air are gradually put into motion in a downward direction, the motion being an accelerating one until the after edge *F* of the blade is passed. In this way a greater pressure than the atmospheric pressure is produced on the under surface of the blade."



PLAN.

SIDE VIEW.

FIG. 66.—GRAFFIGNY—1890.

Mr. *Phillips* indicates that such blades may be of wood, 12 ft. in length and 6 in. in width, from the leading edge *E* to the rearward edge *F*, but he does not state what distance they should be apart vertically, having probably ascertained that if spaced 2 in., as formerly proposed, they will interfere with each other. He intends, presumably, to adopt this shape for the slats or blades of the Venetian blinds of his proposed apparatus, when he has worked out to his liking the remaining features, such as the motor and the propeller, the safest modes of rising and of alighting, the best way of shifting the center of gravity so as to correspond with the center of pressure at all angles of incidence, etc. ; but whether he succeeds in this or not, he is entitled to great credit as having been among the first to experiment with other than plane surfaces, and having shown that greater sustaining power can be obtained with wing-like concavo-convex surfaces than with planes, thus drawing attention to what may prove to be an important line of inquiry.

Almost all scientific experiments in air have hitherto been tried with planes, and such few formulæ as have been proposed are based upon the effect on flat surfaces. It is probable that such formulæ—those of Smeaton, Duchemin, Joëssel and others—will be found to need modification, either in form or in constants, when applied to curved surfaces. In such case the tables of "lift" and "drift" heretofore given herein will either need recalculation for each specific curved shape, or require the application of a variable coefficient, as exemplified in the calculations of the power expended by the pigeon as heretofore given. In any case it seems very desirable that further scientific experiments be made on concavo-convex surfaces of varying shapes, for it is not impossible that the difference between success and failure of a proposed flying machine will depend upon the sustaining effect (with a given motor) between a plane surface and one properly curved to get a maximum of "lift."

Fig. 66 represents a kite-like aeroplane proposed by M. *de Graffigny*, a French aeronaut, and the author of several works upon aerial navigation. This apparatus was to consist of a kite 46 ft. across, with its fabric surface capable of bagging to a certain extent, and attached to a longitudinal frame, as shown, which was to be trussed both above and below. In front, a stiff triangular head was to be affixed, and an adjustable horizontal tail was to be placed in the rear. Between these a boat-shaped body containing the machinery and aviators was to be swung on trunnions and attached to the frame. In front of this car a two-armed screw was to rotate, and behind the car a vertical steering rudder was to be placed, above the surface of the kite.

M. *de Graffigny* estimated that the power required to drive the apparatus was in the proportion of one horse power for every 110 lbs., and he proposed the use of liquefied carbonic acid gas, which he states to weigh but 55 lbs. per horse power, including the motor, the recipient and a supply for several hours. This, of course, was a mere makeshift, a reservoir of power for experiment, and not a prime mover ; inasmuch as the whole apparatus was to weigh but 396 lbs. and to have sufficient sustaining surface (some 1,300 sq. ft.) to come down like a parachute, should the motor break down while in the air. The screw was to be 6 ft. in diameter and 10 ft. pitch, and its shaft was to remain constantly horizontal (this being the object of hanging the car on trunnions), so that the position of the propeller should be independent of the angle of incidence of the sustaining surface in accordance with the theory of the designer.

M. *de Graffigny* states that he experimented with a model of this apparatus in 1890. The screw was rotated some 300 turns per minute by a skein of twisted rubber threads weighing, in the aggregate, 1.1 lbs., and producing 1,085 foot-pounds in 2½ minutes, or at the rate of 7.23 feet-pounds per second, which proved quite insufficient to give to the apparatus (mounted on three wheels, the foremost of which was adjustable) the velocity necessary to cause it to rise upon the air. The designer expresses himself as unable to state what would be the result with a full-sized apparatus.

It will be noted that this proposal resembles a number of others which have already been described. It is probable enough that the best form for sustaining a given weight and for propelling it with a minimum of surface and of power, or for maintaining equilibrium, have not been selected ; but M. *de Graffigny*, in the book * in which this design is incidentally described, strongly advocates the kite principle generally, as the one most likely to lead to success in devising a flying machine, and in learning how to manage it in the air.

This will have occurred to many readers, and it may be interesting to them to inquiry as to what has been published upon past experiments with kites, a subject upon which the writer has found distressing little on record.

Among the first, if not the very first, to call attention to the fact that the study of the kite as a means of obtaining

* "Traité d'Aérostation." H. de Graffigny, 1891, p. 189.

unlimited lifting and tractive power had been unduly neglected was Mr. *Wenham*, who, in his celebrated paper on "Aerial Locomotion," published in 1866, described briefly some very interesting experiments with kites, and who has kindly furnished the writer with some additional particulars. Mr. *Wenham* states that his principal summary of facts was taken from a little book, styled the "History of the Charvolant, or Kite Carriage," by Mr. *George Pocock*, of Bristol, England, who also published a small work on "Aeroplastics," both of them, unfortunately, now having become very rare.

The experiments described took place more than half a century ago, and the purpose of the inventor was not to evolve a flying machine, but to provide a floating observatory to serve in warfare, or to drag wheeled vehicles over land.

The apparatus was, in fact, a huge kite, of suitable size to carry the intended weight, with a chair swung just below, and so rigged that by tightening or slackening the different cords which held it, the wind would meet it at any angle desired, and the apparatus would rise or fall, or could be made to swing a considerable distance to one side or the other. It was so arranged that in case the cords broke, it would act like a parachute, and thus insure safety.

The following quotation, descriptive of the experiments, was given by Mr. *Wenham* in his paper:

"While on this subject we must not omit to observe that the first person who soared aloft in the air by this invention was a lady, whose courage would not be denied this test of its strength. An arm-chair was brought on the ground, then lowering the cordage of the kite by slackening the lower brace, the chair was firmly lashed to the main line, and the lady took her seat. The main brace being hauled taut, the huge buoyant sail rose aloft with its fair burden, continuing to ascend to the height of 100 yards. On descending she expressed herself much pleased with the easy motion of the kite and the delightful prospect she had enjoyed. Soon after this another experiment of a similar nature took place, when the inventor's son successfully carried out a design not less safe than bold—that of scaling, by this powerful aerial machine, the brow of a cliff 200 ft. in perpendicular height. Here, after safely landing, he again took his seat in a chair expressly prepared for the purpose, and, detaching the swivel line, which kept it at its elevation, glided gently down the cordage to the hand of the director. The buoyant sail employed on this occasion was 30 ft. in height, with a proportional spread of canvas. The rise of the machine was most majestic, and nothing could surpass the steadiness with which it was manœuvered; the certainty with which it answered the action of the braces, and the ease with which its power was lessened or increased. . . . Subsequently to this an experiment of a very bold and novel character was made upon an extensive down, where a wagon with a considerable load was drawn along, while this huge machine, at the same time, carried an observer aloft in the air, realizing almost the romance of flying.

"It may be remarked (continues Mr. *Wenham*) that the brace lines here referred to were conveyed down the main line and managed below; but it is evident that the same lines could be managed with equal facility by the person seated in the car above; and if the main line were attached to a water-drag instead of a wheeled car, the adventurer could cross rivers, lakes, or bays with considerable latitude for steering and selecting the point of landing, by hauling on the port or starboard brace-lines as required. And from the uniformity of the resistance offered by the water-drag, this experiment could not be attended with any greater amount of risk than a land flight by the same means."

The reader may perhaps inquire whether there was not some risk that the kite should run away with the wagon when the wind freshened; but Mr. *Wenham* further explains that the kite attached to the "charvolant" or chariot was provided with a smaller "pilot," or upper kite, which was sufficient to support the "draft," or lower kite, when it was relaxed or allowed to float edgewise, on the wind. The "draft" kite had two cords, one attached well forward, and the other attached well aft, running through rings to keep the cords together. If the aft cord was slacked off by the driver of the chariot, the "draft" kite floated edgewise on the wind, and the wagon stopped; but by pulling on the aft cord the kite could be made to face the wind absolutely, and to produce the maximum of draft.

Mr. *Wenham* also mentions in his paper Captain *Dansey's* kite, for communicating with a lee shore, as described in Vol. XLI. of the "Transactions of the Society of Arts." This was made of a sheet of holland fabric exactly 9 ft. square, and, as stretched by two spars placed diagonally, spread a surface of 55 sq. ft., the remarkable fact about its performance being that in the experiment about to be quoted this surface of 55 sq. ft. sustained no less than 92½ lbs. The quotation is as follows:

"The kite, in a strong breeze, extended 1,100 yards of line ⅝ in. in circumference, and would have extended more had it been at hand. It also extended 360 yards of line 1½ in. in circumference, weighing 60 lbs. The holland weighed 3¼ lbs., the spars, one of which was armed at the head with iron spikes for the purpose of mooring it, weighed 6¾ lbs., and the tail was five times its length, composed of 8 lbs. of rope and 14 lbs. of elm plank, weighing together 22 lbs."

This latter kite seems to have been provided with a tail to steady it in the air, and in considering the bearing of such experiments upon possible flying machines, it is preferable to select those upon tailless kites, sailed with one single line, for it is easy to maintain the stability if several restraining cords be used. Mr. *Wenham* has kindly furnished to the writer the particulars concerning a tailless kite, or, rather, series of superposed kites, patented in Great Britain in 1859, by *E. J. Cordner*, an Irish Catholic priest, who designed the apparatus to save life in shipwrecks, and who preferred to arrange hexagonal disks of fabric (stretched upon three sticks), above each other on the same line, so that they would all pull together. The operation was to be as follows:

When a sailing vessel had struck, which almost in every case occurs by the ship being blown on a lee shore, a common kite was to be elevated in the usual way from on board the vessel. When enough cord had been paid out to keep the kite well suspended, the end of the cord on board was to be attached in a peculiar manner to the back of another and larger kite (without tail), and the second kite was then to be suffered to ascend. The end of the suspending rope was to be attached in a similar manner to the back of another and still larger kite, and the process to be repeated until enough elevating and tractive power was obtained, when a light boat or basket with one occupant was to be fastened to the kite line, the latter being paid out until the occupant reached the shore and alighted, when by means of a light running line, extending from the ship to the person ashore, it was deemed easy to haul the basket back and forth as many times as necessary to rescue the passengers and crew.

It is not known whether this ingenious method of saving life without extraneous aid was ever used in a case of actual shipwreck, but it was tested by transporting a number of persons purposely assembled on a rock off the Irish coast, one at a time, through the air to the main land, quite above the waves, and it was claimed that the invention of thus superposing kites so as to obtain great tractive power was applicable to various other purposes, such as towing vessels, etc.

Many proposals have been made at various times and in various countries to utilize kites in life saving, but none seem to have come into practical use. Such attempts may have suggested to Mr. *Simmons* (the English aeronaut) the experiments which he is said to have tried, in 1876, of gliding downward under such buoyant sails.

The only accounts which the writer has found of these experiments are given in the *Aéronaute* for April, and for November, 1876. The apparatus of Mr. *Simmons* is described as consisting of a huge "pilot" kite 49 ft. high and 49 ft. wide, with another kite below, still larger. The pilot kite was first to be raised, and to carry up the second; the two were to be adjusted to the breeze, and the aeronaut was to be suspended in a car, and allowed to ascend 200 or 300 yards. Then by adjusting his weight by means of guy lines, so as to obtain a proper angle of incidence, the apparatus was said to glide downward to the ground, being slightly dirigible through the guy lines, and to be arrested by the bystanders seizing a dragging guide rope.

Mr. *Simmons* is said to have been fairly successful with his experiments in England, but to have failed to repeat the feat at Brussels, Belgium. In the latter case it was claimed

that there was not sufficient wind, but steadiness of breeze would be more important. The surfaces operated with seem to have been very large—some two to three square feet per pound in order to alight gently; but such extent of surface is so unmanageable in a gusty wind as probably to have led to the abandonment of the experiments.

The exploit is feasible, and would prove useful in experimenting with various shapes and extent of surfaces, but such experiments should be tried with areas more nearly corresponding to the proportions which exist in soaring birds, and the operator should invariably alight in water until he has learned how to manage his apparatus.

(TO BE CONTINUED.)

CARE OF FOUNDATION BRAKES.

AT the January meeting of the New York Railroad Club Mr. James Howard read the following paper on the Care of Foundation Brakes:

"The subject which I have proposed for consideration is one that may appear upon the face of it to need but little attention, from the fact that foundation brakes are as old as railroading, and every railway man is supposed to be familiar with them. The necessity of using the term 'foundation brakes,' so far as railroad cars are concerned, came in with the application of power—other than manual—to the old-fashioned brake. It appears that those who furnished the mechanism for supplying the power were not content to describe it as an apparatus for operating the brakes, but whether the power applied was hydraulic, steam, air or vacuum, the brake that did the actual work upon the wheels was appropriated, and although it was the same old brake, it became at once a hydraulic, steam, air or vacuum brake, according to the respective manufacturers; yet what these manufacturers supply is in no sense a brake, but merely an apparatus for supplying the power whereby the old brake is operated. I call attention to this feature because it has been the means of eclipsing the importance due to foundation brakes; for instance, the adoption of the air-brake has rendered it necessary to establish schools of instruction with elaborate sets of apparatus, test stations, inspectors, etc. Rules have been formulated, both by the railroad and air-brake companies, all to enforce a knowledge of *the apparatus that supplies the power to the actual brake that does the work*, and so it comes to pass that while there is no lack of printed instructions upon air-brake apparatus, we look in vain for any printed rules for the guidance of those who have the care of the foundation brakes. At the same time we know full well that no matter how perfect the air-brake apparatus may be, if the foundation brakes are defective there is no brake upon the train. In fact, so far has this eclipsing process gone on, that it is impossible to find many who are competent to tell you why the air-brake apparatus did or did not do its duty, yet they are puzzled to explain why the train did not stop when it ought to have done so.

"Of late I have had special facilities for observing the condition of foundation brakes, and to say the least it is surprising how widely spread is the inefficiency of these brakes. The knowledge of this fact is the more important because this inefficiency seems to exist in many cases without the knowledge of those in special charge of brakes, and is often brought to light only by some case of emergency. In conversation with a brake inspector upon this subject, he assured me that there were very few who really understood foundation brakes, and fewer still who knew when a foundation brake was in good order, that in fact there were very few trains running with all their brakes in perfect order. 'You see those cars over there,' he said, pointing to several sidings full of passenger cars, 'I can assure you that not one of those cars has a perfect brake upon it.' I have since learned that this testimony might be duplicated on other roads; so general is it that my experience teaches me that the somewhat hackneyed expression, 'the air-brakes failed to work,' would be nearer the truth if changed to 'the foundation brakes failed to work.' I lately saw a train of coaches, in a yard test; the brakes upon these coaches showed 6 in. of piston travel, but out on the road, under an emergency application, the full stroke of the piston was exhausted and the brake pistons were dead against the cylinder-heads. The trucks under these coaches were the ordinary four-wheeled swing-beam trucks with wooden brake-beams trussed with ⅞-in. rods. There was ⅜ of an inch clearance between the friction plates upon each side of the truck transoms. Each of the axle-boxes and pedestals showed from ¼ to ⅜ of an inch clearance upon each side. The center-plates and king-bolts were worn so that it was not difficult to see that even if the brake rigging itself were in perfect order all this free slack must be taken up before there could be any application of the brake-shoes to the wheels, and the reason why these brakes only showed 6 in. of piston travel when tested by an ordinary service application, and exhausted the full piston stroke on an emergency application, was because a service application afforded sufficient power to take up a certain amount of this slack and apply the brakes, while in an emergency application, owing to the free slack in the pedestals, truck transoms and center-plates, the truck wheels were drawn closer together and the trucks themselves were drawn bodily toward the center of the car; add to this the deflection of the wooden brake-beams and the exhaustion of the piston stroke is sufficiently accounted for. In this case the only fault in the brake-rigging was the weakness of the brake-beams, and the sooner wooden brake-beams are exchanged for steel or iron, the better. In other respects the air-brake apparatus and the foundation brake-rigging did its work, but the condition of the trucks rendered the whole brake defective.

"By far the larger amount of inefficiency in foundation brakes arises from the bad adjustment and incorrect spacing of levers and rods. There is still a large amount of brake-rigging in use that does not come under the Master Car-Builders' standards. Some of this is out of all proportion to the work required of it. Cylinder levers of ⅞ iron, the pin holes in which are spaced 9½ in. and 11½ in. respectively, even supposing this was correct for the amount of power required, yet to give the end of a lever a 9½-in. fulcrum that may be called upon to make a 10 or 11-in. stroke is open to criticism. There are quite a number of coaches that have such levers in their brake-rigging; with such levers it does not take a very large accumulation of slack before cramping takes place. Another source of inefficiency is found in the manner in which the brakes are hung. Brake-shoes should be hung as nearly as possible upon a line with the center of the axles. Some are hung so low down upon the wheels that not only is the truck twisted out of shape every time the brakes are applied, but the truck levers are by this means kept so low that to couple them with the floating levers the rods are forced out of line, being drawn down over the truck transoms, so that the friction thus produced absorbs a considerable amount of power and the effect upon the brake-shoes is weakened. Then there is the cramping of clevises, caused by an improper set in the jaws, binding of the rods upon the hangers, the absence of stops upon the brakemast chain, the pull rods coupled up unequally. Sometimes one and sometimes all of these faults are present at the same time. I recently saw a mail coach that had its brake so cramped that with the air full on and 6 in. of piston travel there was no pressure upon the brake-shoes. When the pin was knocked out of the cylinder lever the rod sprang back 6 in., and this was on a new modern coach. Rods too long or too short are a constant source of trouble. There is no valid reason why this should be the case. It does not take very long to overhaul a brake to find and cure this trouble, and it will always repay the time spent upon it. I have before, elsewhere, mentioned a method of doing this, which is the best I know of, and as my object in introducing this subject here is that you may follow it up with practical results, I submit it to you for your criticism; doubtless the system mentioned is nothing new, but simply requires more frequent and general use.

"First put on a complete new set of shoes. Uncouple the cylinder levers from the pull-rods. Clamp the brake-beams to the wheels, using a piece of ¼ plate between the shoe and the wheel. Set the truck-levers at their proper angles, then take the length for the bottom rod between the two truck-levers. Set the floating-levers at their proper angles, then measure the length required for the pull rod, which joins the top end of the live truck-lever with the floating-lever. From the other end of the floating lever measure the length required for the hand-brake pull-rod, taking care that this rod has a good, firm stop-bracket and block before it reaches the brake-mast chain. Set the cylinder-levers at their proper angles, usually 60°, and measure the length between them and the floating-levers for the main pull-rods. Then take the length of the space-bar between the cylinder-levers. See that the rods are so hung that they go in direct lines to their work, that they are not deflected over the transoms nor in any way cramped by their clevises or their hangers, that all pins fit well and can be inserted and withdrawn without straining. The ¼ plate is inserted between the shoes and the wheels in order to give the necessary amount of piston travel to pass the leakage groove, and can be varied to meet any desired travel.

"And now allow me again to urge the necessity and importance of doing something in this matter. So far as I am

aware there are at present no written rules for inspectors that cover the vital points in foundation brakes, and none of our brake inspectors are specially instructed in them, nor are their duties in regard to them defined. It would not be hard to draw up a few concise rules to cover the points I have mentioned. The inspector's attention should be drawn to the positions of levers and rods; he should see that there is no cramping in the jaws of the clevises, no binding on the hangers, no undue friction around the floating-levers; that all hand brake-rods have good stops upon them which will relieve the brake staff and chain of undue strain; that rods are not coupled up unevenly; that excessive wear in truck transoms or pedestals and boxes is promptly reported and remedied; that the piston travel is not unduly affected by deflection of parts and is about the same whether a service or emergency application is made. There are other points, no doubt, that will strike those whose duties bring them in contact with this particular branch of railway service, and I hope practical results may follow."

CAR-WHEEL FLANGES.*

The standard distance between the backs of the flanges of car-wheels, which has been recommended by the Master Car-Builders' Association, is 4 ft. 5⅝ in. as shown at *A*, in fig. 1. The same Association has recommended that in fitting wheels on axles a variation be allowed of ⅛ of an inch each way from the standard distance of 4 ft. 5⅝ in. between flanges, making the maximum distance 4 ft. 5¾ in., and the minimum 4 ft. 5½ in., as shown at *A*, fig. 1. This was adopted in 1885.

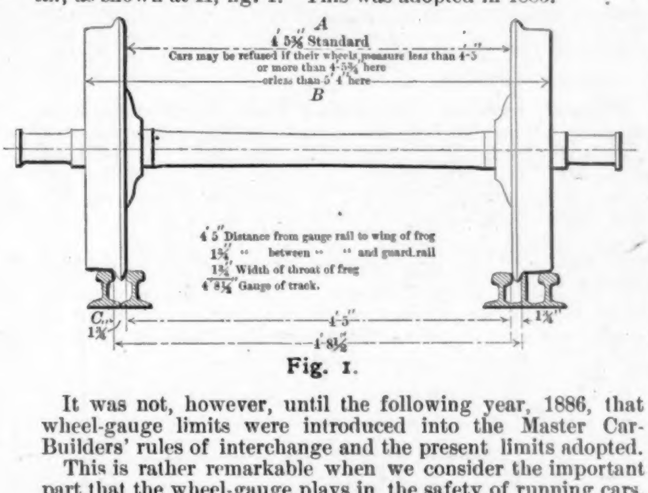


Fig. 1.

It was not, however, until the following year, 1886, that wheel-gauge limits were introduced into the Master Car-Builders' rules of interchange and the present limits adopted. This is rather remarkable when we consider the important part that the wheel-gauge plays in the safety of running cars. Moreover, it was not a new idea; various lines had for years previous to this adopted limits for the distances between and over flanges. Perhaps the real reason for so long evading the question in the rules was the difficulty in reconciling the interests of the roads using a 4 ft. 8½ in. gauge and those using 4 ft. 9 in. As the standard wheel-gauge for 4 ft. 9 in. track

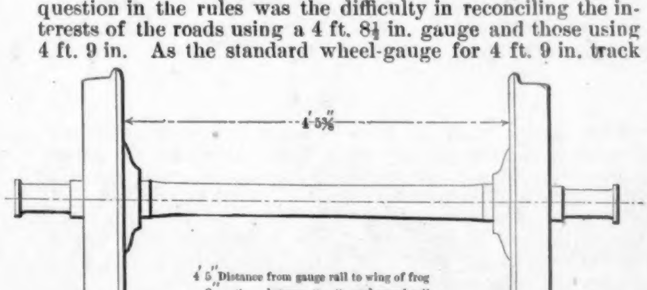


Fig. 2.

and 4 ft. 8½ in. track must necessarily be different, let us consider how it was possible for these two interests to adopt the same limits. First of all, let us understand thoroughly why 4 ft. 5 in. is the minimum limit. Simply because 4 ft. 5 in. is the distance between the guard-rail and wing of frog, both for 4 ft. 8½ in. and 4 ft. 9 in. track. In the former case by having 1¾ in. space between gauge and guard-rail, as shown at *C*, fig. 1, and also between the frog point and wing of frog, shown at *D*, and in the latter case, fig. 2, by having 2 in. at the same points. Any wheels measuring less than 4 ft. 5 in. between flanges would have a tendency to either mount the guard-rail, or by crowding its way through bring stresses likely to produce broken axles.

Let us next consider the reasons which make a maximum limit important.

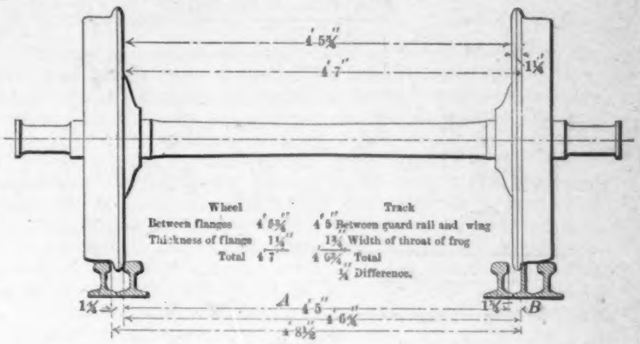


Fig. 3.

Referring to fig. 3 we find:

WHEELS	Maximum between flanges	4'–5¾"
	Thickness of wheel flange (M. C. B. Section)	1¼"
	Total	4'–7"
TRACK 4'–8½"	Distance *A* from guard-rail to wing of frog	4"–5"
	Distance *B* between wing of frog and frog point	1¾"
	Total	4'–6¾"
		Difference, ¼ inch.

This, it will be observed, is not in keeping with good practice, for it allows a wheel mounted to the maximum limit to strike a frog point on 4 ft. 8½ in. track with a full ¼ in. of wheel, and clearly explains why frog points are so difficult to maintain even on 4 ft. 9 in. track. The maximum limit of 4 ft. 5½ in. as originally adopted in 1886 was more in keeping with the usually well-considered actions of the Association. The change to 4 ft. 5¾ in. was made in 1887. Those allowing this to go through either did not understand the importance of the matter, or were considering the interests of the roads using 4 ft. 8½ in. gauge. If we mount wheels beyond a 4 ft.

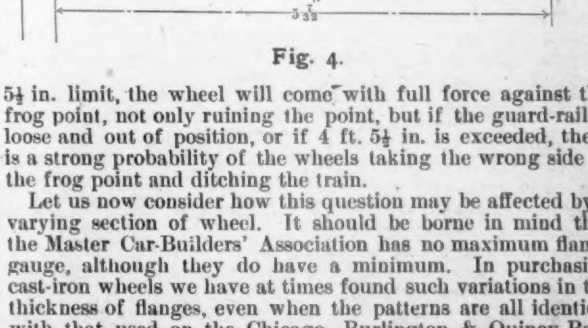


Fig. 4.

5½ in. limit, the wheel will come with full force against the frog point, not only ruining the point, but if the guard-rail is loose and out of position, or if 4 ft. 5½ in. is exceeded, there is a strong probability of the wheels taking the wrong side of the frog point and ditching the train.

Let us now consider how this question may be affected by a varying section of wheel. It should be borne in mind that the Master Car-Builders' Association has no maximum flange gauge, although they do have a minimum. In purchasing cast-iron wheels we have at times found such variations in the thickness of flanges, even when the patterns are all identical with that used on the Chicago, Burlington & Quincy Railroad, that we have found it necessary to adopt a maximum as well as a minimum flange gauge for new wheels. (Figs. 4 and 5 represent these gauges.) Flanges that will not take the maximum gauge (fig. 4) are not accepted, and flanges that will take the minimum (fig. 5) are not accepted. The use of these gauges makes it practical in mounting wheels to use a wheel-gauge each end of which is of the form shown in fig. 6, which at once controls the standard Master Car-Builders' limit between flanges of 4 ft. 5½ in., and inasmuch as the flange contour of the wheel-gauge corresponds with our maxi-

* Abstract of a paper by Godfrey W. Rhodes, Superintendent of Machinery of the Chicago, Burlington & Quincy Railroad, read before the Western Railroad Club, January 17, 1893.

mum flange (fig. 4), it prevents the acceptance of any thick flanges should our foundry wheel inspectors accept wheels that they should not. Few railroads, we believe, use either maximum or minimum flange gauges in inspecting new wheels. At a foundry in this immediate neighborhood (Chicago) we recently found wheels being cast and accepted for service with a flange section that exceeds even the Chicago, Burlington & Quincy maximum limit. Foundries do not always appreciate these differences in railroad practice.

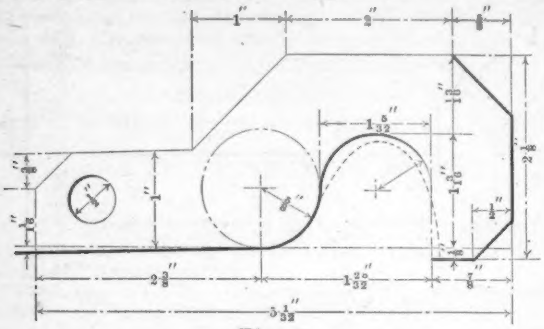


Fig. 5.

Let us consider why with the prevailing practice of mounting wheels there should be uniformity in the thickness of flanges. The Master Car-Builders' standard, as shown in fig. 7, is usually estimated as measuring 1¼ in. through the flange, as at *A* (some would call it 1⅜ in., as at *B*), with the same method of reckoning the thick flange referred to, meas-

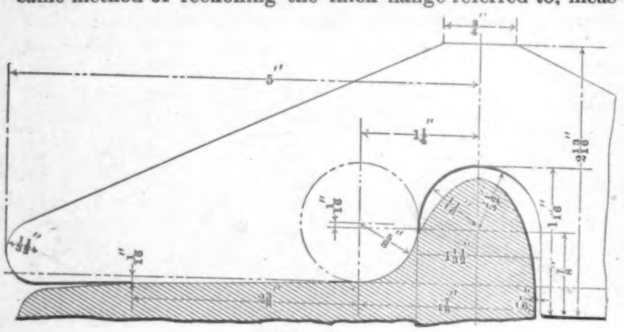


Fig. 6.

ures a strong 1⅜ in. (some would say 1¼ in.) The Master Car-Builders' wheel mounted to the maximum standard allowable between flanges measures as follows over flanges :

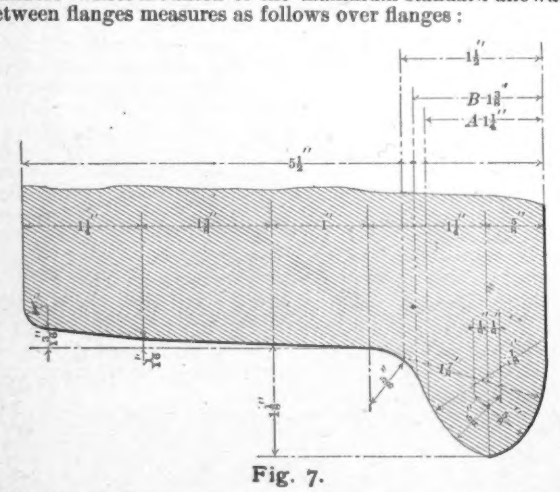


Fig. 7.

Distance between flanges	4′–5½″
Width of one flange	1¼″
Width of one flange	1¼″
Distance over flanges	4′–8″

The above allows ½ in. play on a 4 ft. 8½ in. track. With the 1⅜ in. flange we would have :

Distance between flanges	4′–5½″
Width of one flange	1⅜″
Width of one flange	1⅜″
Distance over flanges	4′–8¼″

Only allowing ¼ in. side play on a 4 ft. 8½ in. track or ⅛ in. on a side. If, however, one chooses to call the thickness of the flange 1½ in. in place of 1⅜, it is apparent that there would be no side play at all on a 4 ft. 8½ in. track.

Let us now consider how such a flange will act on the frog points of 4 ft. 8½ in. track. (See fig. 8.)

Di-tance between wheel flanges	4′–5½″	
Width of flange	1⅜″	
		4′–6⅞″
Guard rail and wing of frog	4′–5″	
Wing of frog and frog point	1¾″	
		4′–6¾″
Difference		⅛″

The flange, therefore, would not clear the frog points by ⅛ of an inch or ¼ in., if the flange in question is rated as measuring 1½ in. Suppose, however, that no exception is taken to thick flanges, and that we attempt to mount them to the standard over flanges :

Standard distance between flanges	4′–5⅜″
Standard thickness of flange	1¼″
Standard thickness of flange	1¼″
Present standard over flanges	4′–7⅞″
Width of thick flange	1⅜″
Width of thick flange	1⅜″
Necessitating a change in standard between flanges to	4′–5⅛″
Present standard over flanges	4′–7⅞″

This leaves but 4 ft. 5⅛ in. between flanges, whereas the standard minimum limit (p. 106, 1890 report) is 4 ft. 5¼ in. If, however, we consider our thick flange as measuring 1½ in., we in the same manner will get for distance between flanges 4 ft. 4⅞ in. If we wish to preserve 4 ft. 7⅞ in. over flanges :

Width of flange	1½″
Width of flange	1½″
Distance between flanges	4′–4⅞″
Distance over flanges	4′–7⅞″

There is, however, still another phase of this question to consider. What has been said is based on the assumption that wheels are accurately mounted within the Master Car-Builders' standards. It is well known, however, that in practice accuracy is not always followed ; the interchange rules provide that cars must be accepted if the wheels do not measure more than 4 ft. 5⅝ in. or less than 4 ft. 5 in. between flanges ; with these figures we get the following results with thick flanges. (See fig. 9.)

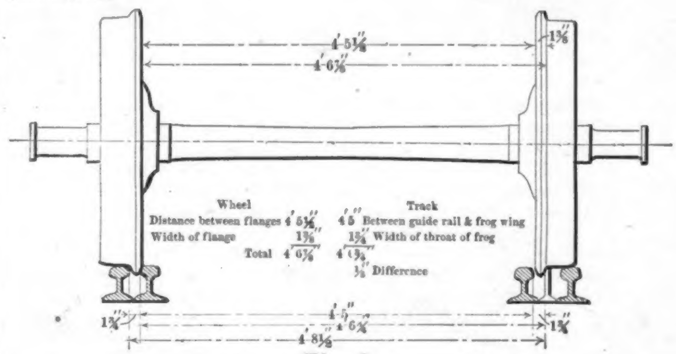


Fig. 8.

With flanges, then, as thick as some foundries are casting them, it is possible to have them mounted within the gauge limits of the Master Car-Builders' interchange rules and still not have them clear the frog points of 4 ft. 8½ in. track by ⅜ of an inch, if we rate flanges at 1⅜ in. thick and ½ in. if we call them 1½ in., and in the case of 4 ft. 9 in. track they would just clear the point with 1⅜ in. flange and strike it with ⅛ in. of wheel, if rated as a 1½ in. flange.

It would, therefore, seem that the thickness of wheel flanges plays an exceedingly important part in the consideration of this question. With the present limits between flanges, as prescribed by the interchange rules, and with no limits whatever for a maximum thickness of flange, a very dangerous and expensive element is quietly being introduced under the rolling stock throughout this country. It is our opinion that a maximum flange gauge should be considered at once by the Master Car Builders' Association, and in adopting the same full consideration should be given to the present wheel gauge limits. There is hardly a month passes on any of the through trunk lines that we do not hear of cars mysteriously leaving the rails. Is it to be wondered at with flanges and gauge limits as outlined in this paper ?

In Mr. R. H. Soule's admirable collation of Master Car-Builders' standards presented at the last Master Car-Builders'

Annual Convention, he makes the rather surprising statement that the guard-rail gauges of the Association are but little used by railroads. This is not as it should be. There is nothing more important on a railroad than track and wheel-gauges, together with a thorough understanding of the relation one bears to the other. A practical illustration of failure in this respect will, perhaps, add force to this statement. On an important joint track in Chicago that is run over principally by passenger trains, a series of derailments took place last fall to through passenger trains, at a frog point located on a 13° curve.

Nov. 22.—First derailment occurred.
Nov. 30.—Second derailment occurred.
Dec. 3.—Third derailment occurred.

As the speed was slow nothing more serious than a blockade of tracks and delay of trains followed. Fully two weeks passed by before the cause of the derailment was discovered and remedied. An examination of the track finally revealed

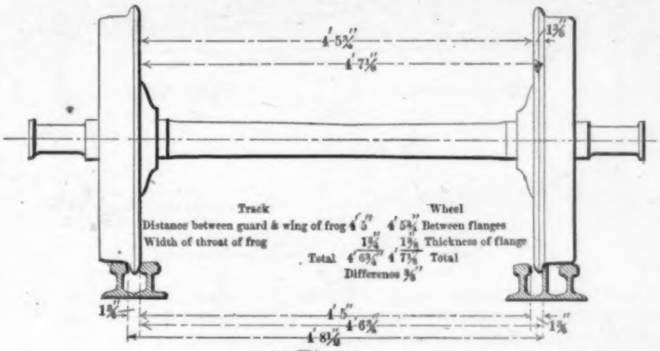


Fig. 9.

the inexcusable state of affairs represented in fig. 10. The track foreman had evidently been endeavoring to save the wear on his frog points without considering any other phase of the question. It will be noticed the distance between guard-rail and wing of frog is actually 4 ft. 5¼ in. It will be thus seen that on the assumption that the wheels were gauged strictly to the Master Car-Builders' standard of 4 ft. 5⅝ in. between flanges, they would not clear the wing of frog by ⅜ of an inch even on the supposition that the flanges conformed to the Master Car-Builders' standard. If, however, the wheels

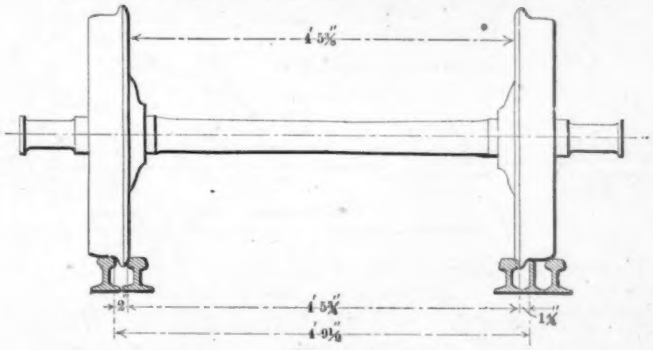


Fig. 10.

were gauged only to the interchange rule minimum limit of 4 ft. 5 in., they could not clear such a condition of track by ¾ in. It seems almost incredible that such a condition of things could exist on a first-class railroad. The facts are nevertheless exactly as stated.

In conclusion, then, for purposes of greater safety to our present highspeed passenger and freight trains, we urge renewed interest in the matter of adherence to Master Car-Builders' standards in wheel-gauges, track-gauges, and wheel flanges. We also recommend for consideration the changing of the maximum limit between flanges from 4 ft. 5¾ in. to that first adopted in 1886—viz., 4 ft. 5½ in., and further, that a maximum limit for thickness of wheel flanges be adopted. By far the most effectual way of bringing about uniformity and safety, however, would be to have a uniform track-gauge. It is very unfortunate that this country should have two standards—4 ft. 9 in. and 4 ft. 8½ in. So long as this exists, and cars adapted to the narrower gauge are allowed to run over the wider gauge and *vice versâ*, each line in fixing its standards must consider the dual conditions that are sure to arise. The subject of uniform track gauge would seem to be one well worthy of consideration by the American Railway Association, which has already done much effectual work in the way of bringing about uniformity in matters which necessarily can only be made effective by action of the managers of our different railroads.

RESISTANCE OF METALS TO SHEAR.

By H. V. Loss, M.E.

The common theory of strength of materials teaches us the action of metals under stress with a fair degree of satisfaction, when exposed to torsional, bending or even most compressive forces. If, however, the engineer or student is called upon to solve a problem where a shearing action is the main element to be considered, he will in vain hunt through text-books or experimental records for light. To be sure, a few scattered experiments have been made, but the writer is not aware of any complete and accurate data pertaining to this subject. The theoretical analysis covering this field is also highly unsatisfactory, there being no formula which the author of this investigation has ever found to be correct and applicable to such problems that will occur—as, for example, in the construction of shearing machinery.

Where a piece of material is to be severed by the action of a pair of knives, no shear will exist in practice without a combined bending action, as the knife-blades will imbed themselves quite considerably into the metal before rupture occurs, thus causing a displacement of the center of pressure away from the shearing edge, which displacement then represents leverage.

The clearance angle of the shear-blade—that is, the inclination of the back of the blades upward and downward from the bar—will have some effect upon the amount of power necessary to a certain cut. This effect is mainly, if not solely, felt with new and sharp blades and on light work. For practical machine construction, where we will have to deal with dulled blades and heavy work, this feature can practically be omitted. The knives will in such cases imbed themselves considerably, regardless of the value of this angle; and the experiments did not indicate that the maximum pressures were depending upon the amount of this clearance. It is proper to remark, in this connection, that the standard practice, as based upon experience, when cutting hot material, calls for no clearance angle whatever, both blades being square to the sides. The cold-shearing experiments, treated in the following pages, were mostly made with knives, the clearance angle of which were 1 in 6.

It has often fallen to the writer's lot to have had to undertake the computation and design of heavy shearing machinery. The repeated vexations due to being forced to fall back upon either guesswork or records of former shears—mostly without knowing whether these former shears *safely could* perform such work—led to the inauguration of a series of experiments with the view of finding a guide for engineers in their professional duties. The word "guesswork" is used with due consideration, as the process of taking the number of square inches to be cut, multiplying this number by a certain percentage of the tensile strength of the material, and then regard this resulting product as the necessary shearing power—this process, the writer maintains, is but very little superior to guesswork.

If a beveled knife were to be used, the same rudimentary method would then call for a certain amount to be deducted from the above-mentioned product, the amount of this deduction varying directly with the tangent to the angle of inclination.

It has for a long time been surmised by the writer that the power to sever a bar would not, in all instances, vary directly with its thickness; nor could the power vary directly or indirectly with any trigonometrical function of the angle, representing the bevel of the knife—the angle crossways to the bar. A consideration of extreme values of this angle will readily prove this hypothesis. With a beveled knife there is also, as a matter of course, a limiting value of the width of the bar, that requires a maximum exertion. Above this value the exertion remains constant.

It has been asserted by a large number of engineers that a bar is severed when the knives have penetrated through one-third of its thickness. This is an assertion, however, that needs verification.

The following questions may properly be asked, as being of special interest to the engineer and student:

1. What is the maximum pressure necessary to sever a bar of given dimensions with knives of known bevel?

2. How does the variation in maximum pressure follow the variation in bevel of knives?

3. When is the maximum resistance reached?
4. How does the resistance vary throughout the cut?
5. What is the energy consumed in severing a bar?
6. What is the difference between iron and steel—generally soft—as to maximum pressure and energy?

The questions of pressure required and energy consumed are, of course, the most vital ones for the practical engineer, but any side-light that may incidentally be thrown on the subject lends additional knowledge to a question hitherto rather meagerly treated.

The above numbered questions refer in a general way only to cold materials, but the resistance of hot steel to shear has lately become quite an important consideration, in view of the large dimensions of ingots and blooms, that are necessitated by the present demand in the market for heavy rails and structural shapes.

The construction of hot shears is now a very important branch of mill engineering, and engineers versed in this branch of our profession are aware of the existing diverging opinions in regard to the shearing resistance of hot rolled materials. The writer therefore included in the programme a limited series of experiments on hot work with the view of finding some reliable data. The results are included in the following pages. The most direct manner, involving the fewest factors of uncertainty, in which experiments on shear can be conducted, is by a hydraulic press. A hydraulic differential machine was so constructed as to reduce the high pressures existing in the shear cylinder down to such a figure that would permit it to engage with a common steam indicator. By attaching this differential machine to the press, the motion of its piston would produce a complete diagram showing the pressures existing at any time during the cut.

COLD MATERIALS.

The shapes of heavy dimensions, mostly considered when designing shearing machinery, are bars of rectangular cross-section and angles. Beams are generally sawed off, while thin plates, as for boiler or tank purposes, require, comparatively speaking, a very small exertion. The above-named shapes may occur either in steel or iron.

The iron in the experiments possessed an ultimate tensile strength of about 50,000 lbs. per square inch. The bar steel had an ultimate of 70,000 to 75,000 lbs per square inch, while the steel used in the angles run somewhat higher, or from 75,000 to 80,000 lbs. per square inch, all of which figures represent small specimen tests—that is, from standard test pieces 8 in. long and with an area of ½ sq. in. The carbon in the steel ranged anywhere from 0.16 to 0.22 per cent.

1. Rectangular Cross-sections.

a. Ultimate Pressures.

The appending plates from 1 to 5, both inclusive, show the compiled results on 4-in., 5-in., 6-in., 7 in., and 8-in. bars, with thicknesses varying from ¼ in. to 2¼ in. Each plate also contains indicator cards showing the different types, as representing the different bevels of knives. When speaking of a beveled knife it means a beveled top knife only, the bottom knife always being square. It may be of interest to know that the bar, upon being met by the knife, invariably turns around its edge, exactly bisecting the angle between top and bottom knives. This is illustrated by the accompanying sketch, fig. 1.

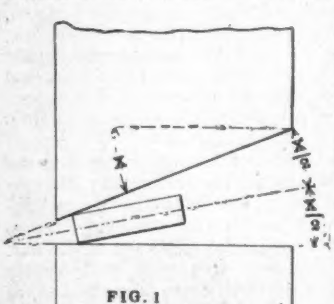


FIG. 1

Repeated measurements proved the accuracy of the above assertion. The angles of top knife used were 8°, 4°, and 0°, or a flat knife. The results, as plotted down, represent generally an average figure or value from a number of experiments on each dimension.

Plate No. 1 shows 4-in. bars with thicknesses from ¼ in. to 2 in. Occasionally a continuous average curve has been drawn through the more or less irregular lines which connect the points, as found by experiments. This is done on this plate in the case of 4° and 8° bevels. An inspection will reveal the quickened increase in power with the increase in thickness of bar. The flat knife shows a rather irregular line; but one thing is, however, obvious: *there is very much less decrease in power experienced by the first increase of 4° in bevel, as compared to the effect of the last* 4°. This is a result which is observed throughout the entire series of experiments. The indicator cards show, nevertheless, a distinct difference in ultimate power for all different bevels. With 8° the knife penetrates gradually through the bar, even after the maximum resistance has been encountered and overcome. With 4° the maximum resistance occurs at a later period; but very little work is done after this point has been passed. With flat knives the point

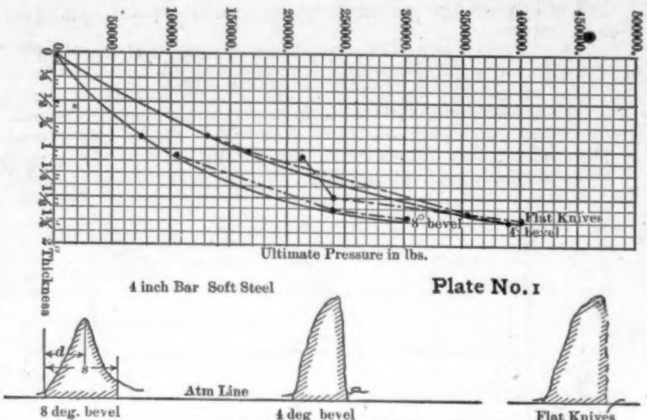


Plate No. 1
Types of Cards from 1¾" Thickness
Scale Hor. Dim. Half size and ⅛ inch vert=350000 lbs.

of maximum resistance comes still later, but when once reached the bar breaks suddenly, as shown by the vibrations of the pencil, clearly indicated on the card.

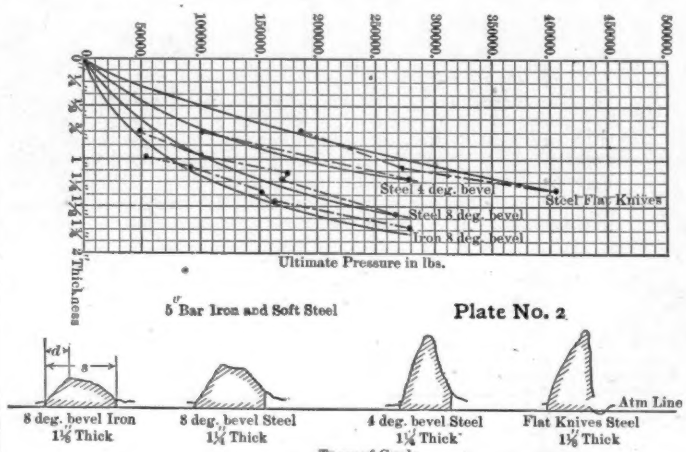
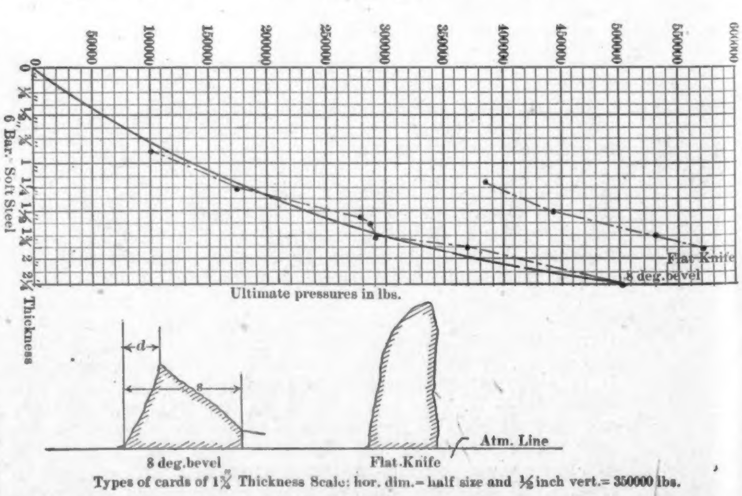


Plate No. 2
Types of Cards
Scale Hor. Dim. Half Size and ⅛ inch vert=350000 lbs.

Plate No. 2 shows 5-in. bars of steel broken at 8°, 4°, and with flat knives. It also shows iron bars of the same dimensions broken at 8° bevel. Iron and steel at 8° show less differ-



Types of cards of 1¾" Thickness Scale: hor. dim.—half size and ⅛ inch vert.= 350000 lbs.
Plate No. 3

ence than steel at 4° and 8°. This peculiarity seemed to exist constantly when iron was introduced into the experiments.

The indicator cards show the same typical forms as existing with the 4 in. bars. With iron the work seems fairly well distributed throughout the stroke, although this distribution is not as uniform, however, with an increasing thickness.

Plate No. 3 shows a very complete line for a 6-in. bar with

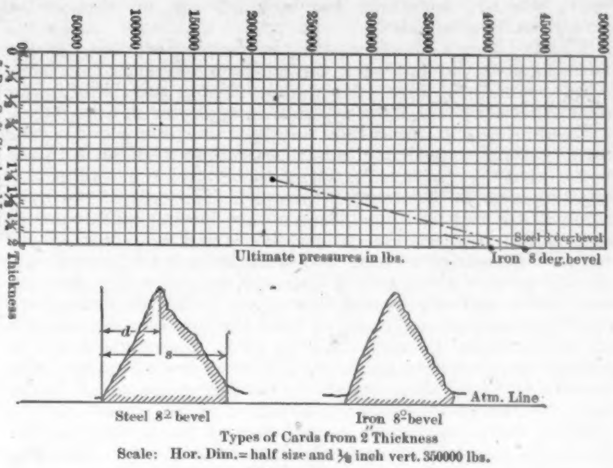


Plate No.4

an 8° knife up to 2¼ in. in thickness. The flat top knife shows also very distinct and positive results. The quickened increase in power with increase in thickness is again here, as everywhere else, clearly indicated.

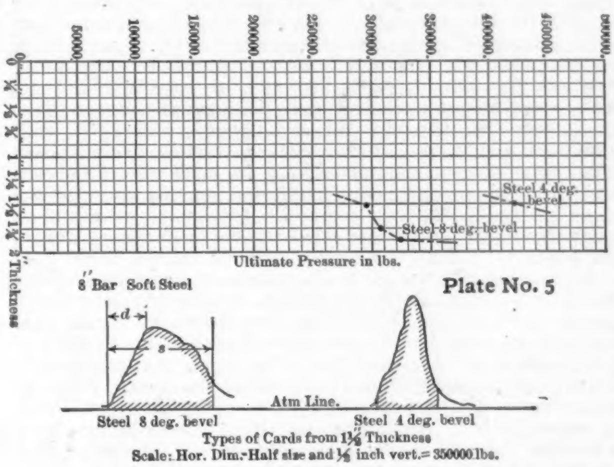


Plate No. 5

The indicator cards emphasize the different distribution of work, due to different angles of knife. The sudden break with flat knives, after the maximum resistance has been reached, is once more demonstrated.

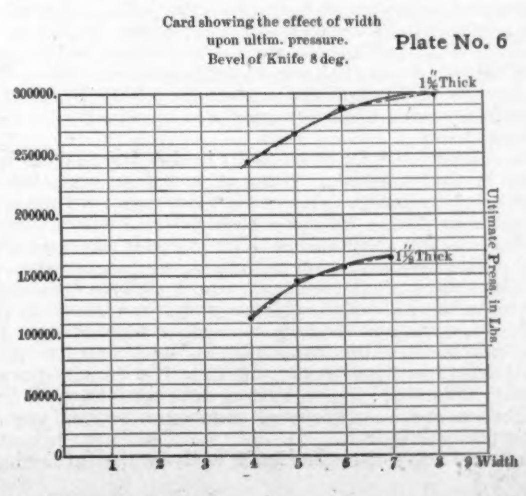


Plate No. 6

Plate No. 4 on 7-in. bars shows, again, the before-mentioned fact, that iron and steel do not give very different results at 8° bevel of knife.

The forms of the indicator cards are also very similar, both as to pressure and distribution of work.

Plate No. 5 shows some results on 8-in. steel bars with 8° and 4° knives. The results do not combat any of the previously mentioned characteristics.

All the experiments so far seem to indicate that *with large bevels, iron and steel vary in ultimate shearing resistance, apparently in a smaller ratio than the one existing between their tensile strengths.* They also seem to demonstrate that *to cause a telling decrease in shearing power the angle between knives ought to be more than* 4°, as an increase in bevel above this figure decreases the shearing power very rapidly.

Plate No. 6 shows the decreasing effect of the width of a bar upon the ultimate power whenever a beveled knife is used. *With 8° it seems to indicate that anything above 8 in. in width, when about 1⅜ in. in thickness, requires no additional power. With 1½ in. thickness the limit seems to be reached at 7 in. in width.* The thickness seems, therefore, to effect the limit to a certain extent, everything else remaining constant, as a difference in thickness of ⅛ in. results in a decrease or increase in the limiting value of width of 1 in. This seems upon reflection to be quite natural. The less thickness of bar the less becomes the absolute penetration of knife, as also the amount of width engaged by the inclined blade or *vice versa* before rupture occurs.

Plate No.7

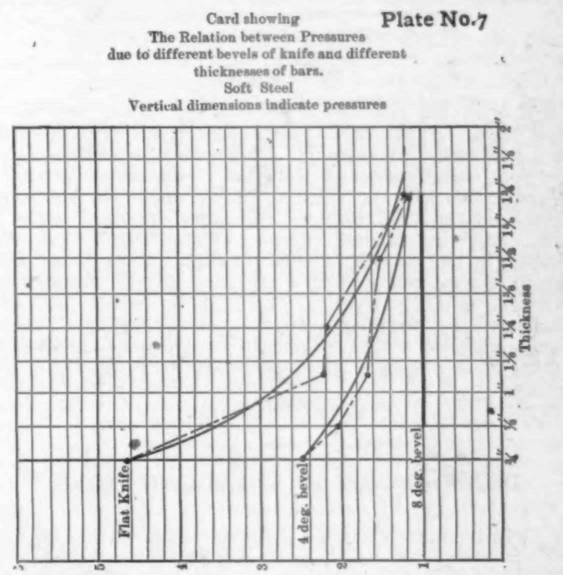


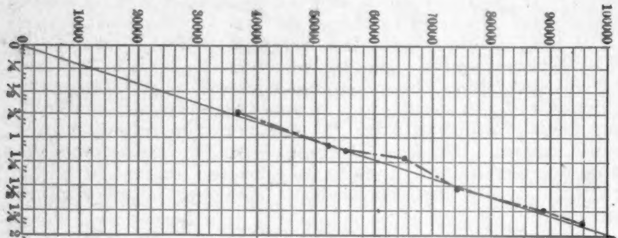
Plate No. 7 shows one important fact. *With increasing thickness the effect of any bevel, however steep, disappears quickly.* At 1¾ in. thickness there is only a difference in shearing power of 19 per cent with 8° difference in bevel, while this very same difference in bevel with ¾ in. thickness causes a difference in shearing power of 360 per cent. This extraordinary difference is mainly, if not solely, due to the fact that with large thicknesses the bar has to be broken instead of sheared. Under such conditions the knives do not penetrate very deeply, comparatively speaking, before rupture occurs, and the effect of the bevel is greatly diminished. At about 2 in. or 2¼ in. in thickness, it would appear that all difference would be eliminated. The following table gives the figures from which the diagram has been constructed. The necessary shearing force with 8° knife has been considered as a basis.

TABLE NO. 1.

Thickness of Bars.	Relation between Pressures with Bevels of Top Knife of		
	8 Degrees.	4 Degrees.	Flat.
¾"	1	2.5	4.6
⅞"	1	2.05	....
1 1/16"	1	1.66	2.00
1¼"	1	1.63	1.97
1⅜"	1	1.54	....
1¾"	1	1.16	1.19

Plate No. 10 shows a very decided result as to the effect of thickness upon ultimate pressure when using flat knives. The vertical dimensions represent ultimate pressures *per inch of width* of steel bar, each separate result being the average value as taken from all widths of bars having any one thickness. The close coincidence between the broken lines and the full line directed toward the zero mark is very apparent. It means *that the ultimate shearing resistance of a flat bar is in direct proportion to its thickness.* This result is foreshadowed on some of the pressure plates, especially on No. 2. In this one instance the old rudimentary method of determining the ultimate resistance seems to approach the truth.

In finishing the remarks on the ultimate resistance of rectangular bars, it is well to call attention to the small resistance per square inch of section that exists with a beveled knife when cutting thin bars. A 6 × $\frac{7}{8}$-in. steel bar requires only 19,000 lbs. per square inch of section with an 8° knife, while



Scale of ultimate pressures per inch of width of bar in lbs

Pressure Diagram per inch of width of flat steel bars.

Flat Knife.

Plate No. 10

a 6 × $2\frac{1}{4}$ in. bar requires 40,000 lbs. per square inch for the same bevel. As the knives become flatter, however, this difference decreases very rapidly. Under these conditions I have, therefore, entirely abandoned the term *resistance per square inch* in connection with the shearing of cold materials, and simply considered the total ultimate resistance. Indeed, when remembering the different complex strains which exist when shearing a bar, especially with a beveled knife, it is almost absurd to use such a term, when expecting all square inches of the bar to do equal duty. We might as well be justified to inaugurate a "bending resistance per square inch," which, when multiplied by the number of square inches in the cross-section of any beam would represent its resistance against flexure.

(TO BE CONTINUED.)

DISCREPANCY IN CHEMICAL WORK.*

By C. B. Dudley, Chemist Pennsylvania Railroad Company, Altoona, Pa.

My theme is: "Discrepancy in Chemical Work by Different Workers." What are the causes of discrepancy in results obtained by different chemists?

I have recently seen a series of, probably, 16 determinations of sulphur in a piece of pig iron, supposed to be the same iron: that differed from each other from 0.005 up to 0.02 per cent., or the extreme results (these figures are given from memory) were about as 1 to 4. Now, obviously, while the amount of sulphur is excessively small in this case, not being a matter of very great importance, yet, as bearing on the accuracy of chemical work, the result is something appalling. I have seen a series of phosphorus determinations recently, made by six or seven chemists, where the extreme results differed 0.03 to 0.04 per cent. in a total of about 0.10 per cent. A friend of mine, who, for a number of years, was manager of a large furnace, some four or five years ago sent out borings from some pig iron to eight or nine different chemists for phosphorus determination—this is another case besides the one just referred to—and when he got the results back, no one of the chemists knowing that any other was working on them, they differed almost as 1 to 2; and, in his nervous, energetic way, he said: "'I said, in my wrath, all chemists are liars!'" Perhaps it is not necessary to mention any more discrepancies; but one more instance may be given. In a recent analysis of bronze, we obtained, in our laboratory, a trifle over 9 per cent. of tin; another chemist, working on what was supposed to be exactly the same metal, being half of the same pig, got over 10 per cent., the discrepancy being about $1\frac{1}{4}$ per cent. Now, obviously, there is something wrong somewhere. Why is it that we get such discrepancies? Undoubtedly, most of you have reasons quite ready to explain some, at least, of the discrepancies. I have gone over the subject recently, and think the causes for discrepancy in chemical analyses may be grouped under four heads. You can say, after I am through, whether there are more; whether the ground has been covered; whether something has been left out, or whether too much has been included.

The first cause of discrepancy in chemical work is that the two chemists did not work on the same sample; or, in other words, non-uniformity of samples. Upon this point, your own experience will doubtless give each of you an illustration. I do not have in mind now anything occurring out of our own personal experience in our laboratory work at Altoona, now nearly 17 years of it, where there has been serious discrepancy due to difference in sample. The nearest we have come to it is this: At one time we were buying spiral springs on specifications that the carbon should not be below .90 per cent. The springs we examined were made out of a steel wire about a quarter of an inch in diameter, the coil being about an inch and a half across, and five or six inches long, what we call "A" springs, and used to hold the box lids tight to the oil boxes under the cars. We found in those springs so low carbon, in a number of cases, that we rejected them. The manufacturer got some one else to determine the carbon in the steel, and found the requisite amount; and so, of course, the question came up for an explanation as to the discrepancy. The discrepancy was very easily explained, and we ourselves, in our later work, found the same peculiarity in other steels; the borings required for analysis of these springs (they were unhandy, unwieldy things to bore, being small) were simply what we could get handily, mostly from the outside of the wire. The manufacturer took the same springs, had the outside turned off, and then took his sample from the center of the wire, and this was the cause of the discrepancy, as we have proved by a number of test analyses. Apparently the outer layer of a steel rod that has been heated, as is commonly done with spiral springs, very frequently loses .10 per cent. of carbon in the fire. Or it may be, segregation during cooling explains the difficulty. At any rate, we have several times done this—viz., take a wire rod $\frac{5}{8}$ in. in diameter, and have the boring done from the side, not the end, with a $\frac{3}{8}$-in. drill, may be $\frac{3}{16}$ in. deep, and then make a carbon determination from these borings, and then take $\frac{3}{16}$ in. more toward the center and make a second carbon determination; we never get the same carbon in the two samples. This is the nearest to an easy illustration that I can give you of discrepancy due to difference in sample. Of course, it is perfectly obvious that if the samples differ, there is a legitimate and good reason why the analyses should differ. This is especially true of shipments that are made up of large quantities, and are sampled by the single sample. We have many times had this brought to our attention by the men at the shops. Samples taken out of the same lot of material may not show up the same. They say it is the same material because it came in the same car. This is especially true in oil samples. It is not at all rare for a manufacturer who receives an order for 50 barrels of lard oil, for example, not to take that oil all out of the same tank, although he ships the 50 barrels in the same car. We have had a number of cases where the amount in tank did not suffice to fill the order, and, consequently, some was taken out of another tank, and sometimes inferior material was put in—two or three barrels, as the case might be—to fill the order. But it is not necessary to go further upon this point. You will all recognize that there is a clear and sharp reason for discrepancy in analyses if the samples are not the same; and in all our work, when we come to a serious difference between ourselves and any one else, we exchange samples. That is one of the first things we do—exchange samples to see whether the difference lies there.

The second cause for discrepancy in chemical analysis is impurity in the chemicals. Many of you have doubtless run across this peculiarity. One of the most recent we ran across was this: In mixing up some wash water of sulphate of ammonium and free sulphuric acid for washing the yellow precipitate in phosphorus determinations, we ran across a very puzzling sort of trouble—namely, after washing a few minutes the filtrate became turbid, and the more we washed the more turbid it became, and we were inclined to think that the published statements of the insolubility of the yellow precipitate in sulphate of ammonium and sulphuric acid wash water were probably fallacious; but on looking into the matter we found that the commercial sulphate of ammonium we had used had a little phosphorus in it.

There are many discrepancies in analyses due to the impu-

* An address before the members of the Chemical Section of the Engineers' Society of Western Pennsylvania at Pittsburgh, September 27, 1892.

rity of the chemicals used, and it is not always an easy matter to say whether the chemicals are pure or not. It may frankly be said to you that the longer I work, and the more experience I get, the more I am inclined not to be so sure as I used to be. Obviously, there are two or three methods of checking up whether the chemicals are pure or not. One of the most common is simply to test the chemicals; but it is not clear how anybody would have found the impurity by that method, which was run across in the work of the International Committee on Standards in carbon determinations—namely, the presence in chloride of ammonium of a little organic matter, that only comes out when you dissolve steel in the double chloride of copper and ammonium. Another method is to make a dummy analysis, using a second beaker, to which you add only the reagents that you use in the one containing the substance to be analyzed, and then weigh up what you get from the two, and deduct from the genuine analysis what you find in the dummy. There is always a little uncertainty in that—namely, have the same reactions taken place in the beaker that has not got the substance in to be analyzed that have taken place in the beaker that has the substance? There is one thing more present in the beaker that has the substance in, and this additional thing may introduce changes in the final result. The dummy analysis is not always quite certain; in many cases it undoubtedly is. You may not always catch up the impurities of the chemicals by the dummy analysis, nor would I think that you could always catch up the impurities of the chemicals by a test, as it is so difficult sometimes to test them.

This is a thing that all of us, undoubtedly, need to pay a great deal of attention to. Your attention may be called to an instance. We had some so-called C. P. molybdic acid from five different sources recently; three of them had ammonia present; one of them was free from ammonia, but there was a little soda or some other soluble base with it; and one of them was pure molybdic acid, as far as we could get at it. Such peculiarities as these many times may possibly cause discrepancy. It is evident that in making up a solution of molybdate of ammonia, if you have something called molybdic acid, and put in the amount required of this material, and it is in reality molybdate of ammonia or of soda, you do not get the same strength of solution you would have if genuine molybdic acid had been used. Our experience indicates that this point cannot be ignored in phosphorus determinations. Your own experience will, of course, do two things for you: first, warn you (has already warned you undoubtedly) never to trust results of analysis unless you have checked up the chemicals, and, second, will convince you that there are many impurities in so-called C. P. chemicals.

A third cause of discrepancy in chemical analyses is what may generally be called "poor manipulation." There are chemists who think this is the principal cause. The main cause of discrepancy in chemical analyses, some say, is poor manipulation, or lack of skill. My old teacher in chemistry, who has now gone out of the business, and lives on a farm in California, was characterized by this one very remarkable peculiarity—namely, he never believed anything as long as there was a shadow of doubt, and after all known uncertainty had been removed he was not quite sure; in other words, he was a man who was really a struggler for accuracy. He used to say to me in his very dry way: "No chemist can make an accurate analysis. There are chemists who can work near enough to accuracy so that their work is valuable. There are chemists who cannot. And that is the difference between chemists." Of course, what I mean by an accurate analysis is a question of limits. Some analyses are accurate to a half per cent., some to a tenth of a per cent., and some, perhaps, to a hundredth of a per cent., but probably none are the exact truth.

The point I want to make, however, is not a dissertation on accuracy, but the difference between chemists due to manipulation. Undoubtedly, this is a very frequent source of error. I remember very well when I was a student, I was set to make a determination of iron. I dissolved the substance in sulphuric acid with the utmost care, excluding the air, and, at the end of the operation, after going through the necessary routine, I filled up my flask to one litre, shook, and supposed I had a solution that was in every sense what it should be for the subsequent operations, which were to draw out successive portions of 100 cub. cm., and titrate them with permanganate of potash. To my surprise, the first two that came out differed from each other from 10 to 15 per cent. What was the difficulty? Why, simply, I had not mixed the materials. I thought, in my inexperience, that if they went into the same flask, it was all right if I gave it a shake and a stir. Let me give you another illustration. Recently, we had occasion, in our laboratory, to make some tests for phosphorus, and I set two or three boys at the same thing. We knew pretty well from good careful manipulation and fairly well-tested methods what the steel contained, and the directions were to wash the yellow precipitate until the wash water tested with sulphide of ammonia showed no change of color. We were washing out molybdic acid and iron salts, and, as you know, both the molybdic acid and the iron would show change of color with sulphide of ammonium. In some five determinations, one of the boys got (it was low steel, containing almost exactly 0.4 per cent. of phosphorus) .048, .047, .051, .043, .045. You will note the discrepancy, and yet he had followed the directions, as he supposed, with absolute accuracy.

There are two points involved in this illustration—namely, to show how the manipulation may be at fault, and, also, however accurate you may be in giving directions as to how analyses shall be conducted, you may be thwarted by something you had not thought of. Well, on careful examination, we located the difficulty. The difficulty was simply this: the yellow precipitate had a little tendency to crawl, and this manipulator was a little bit afraid it would get over the top of the filter, and, possibly, get carried down through with the washings, and in his anxiety to avoid this he failed to wash all the molybdic acid out of the upper part of the filter. He supposed he was washing it out completely, but as the result showed by failing to wash to the top of the filter he removed so little with each successive addition of wash water that the amount was too small to react with sulphide of ammonium, so that, although he accurately followed the directions, he still left enough molybdic acid (which you know, by the volumetric method, is what we are really measuring) in the filter to give a little high results.

Hundreds of illustrations will, no doubt, occur to you where manipulation comes in as an element of error. Directions are given, say, for example, to heat to a certain temperature. One man guesses at it; another puts in a thermometer. Again, the directions may be very indefinite. They may be, for example, "add a little of this or that," or "add a little, not too much," without giving any measurements whatever. Or the directions may be accurate—"add 5 c.c.," or "10 c.c."—and one man guesses at it, and another measures it. The manipulation certainly does affect the analysis. In filtering, one man slops a little, and another does not. All of these are points that come in, so that I think, without further question, you will accept this as one of the reasons why there are discrepancies in analyses—namely, failure on the part of one or the other of the chemists in accuracy of manipulation.

Now there is a fourth cause for discrepancy in analyses, if I understand it rightly, and that is the method. I think you will all agree that two methods may not give exactly the same results. I have in mind a couple of cases which occurred quite recently with us. In a determination of tin in bronze, we never weigh up the metastannic acid as we separate it from the bronze by means of nitric acid. We have never succeeded yet in getting all the iron and all the copper away from the oxide of tin by means of nitric acid. Also if the bronze contains any phosphorus, it will, as you know (part of it, at least), go down with the tin. Even if you take an ordinary straight bronze that is simply a copper-tin alloy, and dissolve it in nitric acid, and weigh the tin just as you get it by separation in nitric acid solution, we think your results will be a little high. So we dissolve our metastannic acid in sulphide of ammonium, filter and reprecipitate the tin sulphide; in this way we always get a little copper out, and sometimes a little iron. And although, as you know, we do not even with this care completely separate the copper from the tin, owing to the solubility of copper sulphide in sulphide of ammonium, we think we get much nearer the truth than if we neglected this precaution. On the other hand, I have known cases where it is quite the custom to weigh up the metastannic acid just as it is separated from the other constituents of the alloy by means of nitric acid. Now here is difference of method. No one would think those two methods ought to give the same results.

I have another illustration: We have been accustomed for a little while to determine the lead in alloys by precipitating lead on one of the poles of a battery as binoxide, according to Edward Smith's recent manual of electro-chemical analysis, a book which, by the way, each and every one of you ought to have and study carefully. I need not give you the detail of the method further than to say, that if you have copper and lead in nitric acid solution and apply the battery, the conditions being all right, the copper precipitates on one pole as metallic copper, and the lead on the other as binoxide. If we may trust our experience the results are excellent, if you have nothing else but copper and lead present. We took a known amount of lead and put in with it a known amount of copper, and get out almost the actual amount we put in, so that we think the method is capable of great accuracy. But in a re-

cent analysis of a bronze containing lead we got 1 per cent. higher in lead than somebody else got by the sulphuric acid method, and the worst of it was that when we came to determine the lead by the sulphuric acid method, we confirmed the other chemists' results. It took a little time to find out where the difficulty was. I may say, for your information, that bismuth follows the lead, if it is in small amount; if it is in large amount, it will go with both the copper and the lead. We found a trace of iron in with the lead, and just the faintest trace of copper, a little tin, a trace of antimony, and strong suspicions, but not positive proof, of bismuth, apparently enough, in the aggregate, to account for the discrepancy. So we see that all methods of procedure are not equally good. All methods will not give the same results. "Method," therefore, is a fourth cause of the discrepancies in chemical analyses.

I would like to spend just a moment on another thought that comes in perhaps under manipulation best, but almost seems worthy of a place by itself—namely, there is frequent discrepancy, if we may trust our experience in chemical analysis, due to the fact that one chemist knows what he is doing, and the other chemist simply follows directions and doesn't know what he is doing. I have seen a good many chemists make chemical analyses whose minds seemed to be anywhere else except upon the analysis; whose minds did not follow the changes that were taking place; who did not understand the rationale of the process. I have seen other chemists whose minds were always engaged upon the changes that were taking place while they were making the analysis, even during the filtration. One thinks, "What are we washing out?" The other thinks only, "The book says, wash," and so he goes ahead and washes. He doesn't think what he is washing out, and usually doesn't test to see whether he has washed it all or not, unless, perchance, the book especially says so; he is thinking of something else. We had an illustration of this lack of thinking what is going on in the progress of an analysis which caused us a little annoyance recently. This very puzzling thing happened to us: We made an analysis of a tire and found about .14 per cent. of silicon in it. The analysis was made by the Drown method, dissolving in sulphuric and nitric acid evaporating until the sulphuric acid fumes, and then diluting with hot water and filter. You are doubtless all familiar with the manipulation. As I said, we found .14 per cent. of silicon in this tire. About a month after it was sent out we received a letter from a chemist of another railroad, saying that he had seen the analysis that we made of the tire, and that his determination of the silicon in the same tire was nearly double ours, and asked us to kindly send him our method, so that he could check himself up and see where he was wrong. He was very nice about it, you see. Before sending him the method, we though we would go over our own work again, and upon doing so, confirmed his results. I would like to say here, in parenthesis, that the average of our work does not cause us this trouble. We make a great many hundreds of analyses, and these are only a few cases, but they happen to illustrate my remarks, and it is better that I should draw my illustrations from my own experience, if possible. Where was the difficulty? Our subsequent work, I say, confirmed the analysis of the other chemist; we got .28 per cent., same as he did. On looking the matter over we found the difficulty. A great deal of work is done in the Pennsylvania Railroad Laboratory, and much of our work is the examination of shipments of commercial products that are bought for use on the road. Now, other people's actions depend on the results of our work. If, for example, we buy a shipment of 100 barrels of oil, none of that oil can be used, unless some very great emergency has arisen, until the laboratory report is furnished to the parties who are to use it, so that we must not allow anything, unless it is very serious, to interfere with our doing that work. It happens, therefore, that the work on shipments takes precedence, and the investigation of miscellaneous samples takes our leisure time when we are not working on shipments. This was the case with the tire. The operator who had the matter in charge, apparently without thinking exactly what he was doing, since he was doing a great deal of other work, and had many irons in the fire, dissolved the steel in the regular way, evaporated to the fuming point (just as he should have done), but, then, instead of diluting with hot water and filtering at once, he diluted and let it stand. It happened it stood 48 hours. Now, it is possible that none of us would have thought that this would cause any trouble, but subsequent experiment showed that this was the explanation of the discrepancy. Apparently, the silicon obtained by the sulphuric acid method is not dehydrated completely. At any rate, we made positive determinations subsequently on the self-same tire, and if we allowed it to stand 48 hours after dilution, we lost about half of it. If we allowed it to stand six days we only got .06 per cent. I said to our boys that I was glad the thing had happened, because it brought out a point we would not have thought of easily otherwise. Nevertheless, it seems to me that a chemist who thinks much, and who carries his work with him, and understands what is going on, would have thought that possibly there might be danger in the delay.

Now, we come to perhaps the most important point in our whole talk—viz., How shall two chemists who differ check each other up? or, come to an agreement with each other? I answer, Where two chemists differ, and the difference is due to working on non-uniform samples, or on not exactly the same sample, the matter is easily checked up by changing samples. Also, differences due to impurity of the chemicals are not very difficult to check up, either by checking up your chemicals, or by the dummy. Sometimes, it is true, the differences due to impurities may be very abstruse and hidden and difficult to find; but by changing chemicals, as we have done a number of times, you can frequently locate the difficulty. Also, still further, where manipulation is at fault, it is not a very difficult thing for the two manipulators to get together and work in the presence of each other, as is frequently done, I understand, in Colorado in assaying. One of my assistants is an old assayer from Colorado, and tells me that, many a time, he and the works' chemist or assayer have worked in the same muffle, side by side, and under the same conditions, so that each could watch the other. Many times it is not necessary to go as far as this; simply talking over the manipulation will show wherein the difficulty lies. These three difficulties—or, rather, discrepancies due to these three causes—are not very hard to overcome; but here comes the poser. Suppose that the difference is due to method, and suppose that I say I have used a good method, an approved method, a published method that is recommended, and you say the same in regard to your method, who is going to decide between us? Both of us are, perhaps, a little obstinate, and both of us perfectly right in the position we have taken. If both of us have used regular, well-recommended methods, who is going to decide between us?

Before answering, let us see what is the necessity for a decision. Oftentimes a good many thousand dollars depends on our work. If we make a mistake by using a bad method or a wrong method, it may mean a good many thousand dollars to somebody whose product we have rejected. He may have to pay the return freight and have the product sent back on his hands; and, as it doesn't pass specifications, he may not be able, without serious loss, to sell it. On the other hand, if the chemist, on the other side, has used a bad method, we may have to accept inferior material. As you know, more and more every day, large commercial transactions are based on chemical analyses, and differences between chemists may mean thousands of dollars.

We have proposed the following method for overcoming this difficulty. I do not know that it will be approved by the profession, but we do not see any other way out of it, and many chemists and managing men of the different mills whom we have consulted on the matter have approved the suggestions we have made. The method is simply this: Publish the method we use, and make it a part of the specifications. For example, suppose we are buying spring steel on specifications that it shall not contain over .05 per cent. phosphorus. Now, we will suppose that I use the volumetric method, another man uses the acetate method, and we get different results, who is going to decide between us? We have either got to leave it to some third party, and agree to abide by his decision, or have the same method. Now everybody knows that it is impossible to run a large commercial laboratory on the acetate method for determining phosphorus; it is too slow; and, also, on the other hand, it is claimed that the volumetric method is not quite so accurate as the acetate method. Perhaps I shall have something to say about that some other time. But what are we going to do? We simply say this to the manufacturer: "We want steel for springs that shall not contain over .05 per cent. of phosphorus, and the phosphorus shall be determined in a given way. Whatever you find by this method, that is the amount of phosphorus so far as our transaction goes." We see no other way out of this difficulty. Now let us see; this is a pretty bold assumption; the chemist of the Pennsylvania Railroad Company assumes to dictate to the profession what methods they shall use. Yes; but only for transactions in which the Pennsylvania Railroad is involved. Use any method you choose for your own work; we do not assume to dictate to you a particle; but as a means of avoiding the difficulty due to difference of method, we simply say to you, arbitrarily, that this is the method that must be used to determine the phosphorus, for example, in transactions where the Pennsylvania Railroad is involved. If we had a standard method, or if any learned society will give a method

which shall be regarded and accepted by chemists as final, we will bow to it instantly; we will adopt anybody's method, if it is applicable. We claim no especial originality; we simply give you the method which we use.

Now let us see what is going to come of this. We prescribe a method which shall be used for determining phosphorus, carbon, silicon, sulphur, or whatever it may be. The method as we use it will give certain results; the other chemist will get the same results, at least we assume that he will. The Pennsylvania Railroad Company puts an upper limit on phosphorus; since phosphorus is injurious to steel, that is to say, the phosphorus must not go above so much; the interest of the railroad company is to have a method that gives as high results as possible, so as to keep phosphorus down; the steel works' chemist, on the other hand, desires that the method in his hands shall show that the steel is low in phosphorus, because if it gets above a certain amount it is rejected. In other words, the two parties are on opposite sides of the method. It is one's interest to have a method that will cause the rejection of the steel if it is high in phosphorus, and the other wants a method that will make the steel pass. Now, my experience is that in anything where men's pockets are involved on opposite sides of a question, you are pretty apt to get at the truth sooner or later. This is going to bring a criticism of the method of determining phosphorus by the parties in antagonistic interest. Our thought is this: The method we send out to-day is entirely subject to revision; if any one of you finds a hole it in, say so, and the change shall be made just as soon as we can make it, providing your work is confirmed. It is not our method; it is a method to be used to decide certain chemical questions. Our hope is that there will be enough criticism by these parties in antagonistic interest on the various methods put forth, so that sooner or later there will result a method which we will all be willing to accept as standard. It may be that the work of 50 chemists will be required before we get such a method. There is no assumption on our part of superior knowledge; no desire to dictate in any shape or form to the profession; but we have a difficulty to meet, and we cannot see how to get out of it in any other way.

I asked Professor Langley what he thought of it. He said he thought that some learned society should approve the method. Per contra, a member of the American Chemical Society is reported to have said that he would bitterly oppose any attempt on the part of that Society to sanction any method. He did not think any learned body should sanction a method. On the other hand, the agricultural chemists of this country, as I understand it, have done this very thing—namely, they have agreed that in the analysis of fertilizers whatever phosphoric acid is shown by a certain method, which they defined in convention, shall be called "soluble" phosphoric acid, and the amount of phosphoric acid that is shown by another method or modification shall be called the "reverted" phosphoric acid, while the amount of phosphoric acid shown by still another method or modification shall be called "in soluble" phosphoric acid. The method was first proposed five or six years ago; has been modified three or four times, and now nearly all the agricultural chemists in the United States, if I am right, are determining the phosphoric acid in fertilizers by the method adopted by the agricultural chemists in convention. If some convention would take this work off our shoulders, we would be delighted. We assume it only because we do not know how to get along and meet our difficulties any other way.

I shall be very much obliged, indeed, for any criticisms and suggestions which any of you may have to make on this scheme, and anything you can contribute in any way, shape or form, you will find falls upon very willing ears.

PROCEEDINGS OF SOCIETIES.

Engineers' Club of St Louis.—At a meeting held January 18, Mr. George H. Pegram presented a paper on The Bridge across the Arkansas River at Fort Smith. A full description of the construction of the bridge was given. The piers were built of concrete, using Portland cement.

Iowa Society of Engineers & Surveyors.—At the annual meeting held at Des Moines, January 18 and 19, it was voted that the Society co-operate with the "good roads" movement in the State. The Society asks that the office of County Surveyor be filled by competent engineers, and that the duties of the office be increased by adding oversight of bridges and of the roadwork in general. It also asks for an examining commission to determine the competency of such officials.

Engineers' Club of Minneapolis held their annual meeting on January 12, at which Mr. Charles Steiner, of Zurich, Switzerland, read a paper upon the utilization of Minnehaha Falls for power purposes. He has investigated and made a preliminary estimate, based upon the flow of about 150 cub. ft. per second as a minimum, with an effective fall of 93 ft. giving about 1,600 H.P.; the cost of the improvement he estimated at $135,000. The scheme would spoil the park, but he proposed to beautify the latter in many respects and let the falls run on exhibition a few hours three times a week. By storing the necessary water in the surrounding lakes and using it in dry seasons he proposed to avoid all trouble from lack of water.

Social Reunion of the American Society of Mechanical Engineers.—This Society has resumed its social reunions for 1893. The first one was held on the evening of January 26, and others will occur March 30, April 27, and May 25. There has been some inquiry among members to learn why the monthly meetings for the discussion of technical subjects, which were tried last year, and with marked success, have not been resumed this winter. Some members say, and it seems with great justice, that if a national Society of Mechanical Engineers accomplishes little more than establishing a lodging-house in New York, and holding a kind of church sociable during the winter and free excursions in the summer, that the Society has failed in the purpose for which it has been organized, and if it does little else might as well be disbanded.

Columbian Engineering Congress.—A recent dispatch from Washington to the daily papers says: "Engineer-in-Chief Melville of the Navy is in receipt of several valuable papers which will form a part of the division of marine and naval engineering of the International Engineering Congress of the Columbian Exposition.

"These papers are to be printed by the seven divisions which constitute the congress. The discussion will take place during the first week of August, and in the discussion three languages, besides the English, are permissible—French, German, and Spanish. All of the divisions have secured papers from the recognized authorities on the subjects treated, and the experts of this country and of Europe have prepared articles which will be valuable contributions to science.

"The officers in charge of the seven divisions are, with the exception of Mr. Melville of the Marine and Naval Engineering Division and Professor Baker, of Chicago, of the Engineering Education Division, New York men. The Division of Civil Engineering is in charge of F. Collingwood, the Division of Mechanical Engineering in charge of F. R. Hutton, the Divisions of Mining and Metallurgical Engineering in charge of R. W. Raymond, and the Division of Military Engineering in charge of Major Clifton Comly of Governor's Island, New York Harbor.

New York Railroad Club.—The February meeting of the Club was held at the rooms of the American Society of Mechanical Engineers on the 16th. The topics under discussion were:

1. Should dead blocks be applied to freight cars with M. C. B. couplers?
2. Can a successful draft rigging be applied to freight cars without the use of auxiliary timbers; in other words, fasten draft gear to end and center sills?
3. Which offers the most security for automatic couplers, a tail bolt or a yoke attachment?
4. Is any device using a netting a real "spark arrester"? If there were absolutely no laws on the subject except that roads should pay for damage done by fires caused from locomotives, would any of us use extension fronts or diamond stacks?
5. What are the best proportions for driving-boxes? Is not the present size faulty design, and can it not be remedied easily?

The discussion on the first topic showed that there was a considerable difference of opinion in regard to the desirability of the dead blocks, but in sifting out the evidence it may be said that it resolved itself into preponderance of opinion in favor of the use of dead blocks. It was shown that the Western roads were using cars on which there were no dead blocks, but that when such cars were in collisions they were more badly broken than cars of Eastern lines, which were provided with the dead blocks. The safety of train men seem to require that the dead blocks should be used, although it was stated that there were more accidents caused from the arm or hand being caught between the blocks than occur by men

being crushed between cars that were violently brought together through the failure of the coupler or draft rigging. Mr. West, of the Ontario & Western road, stated that his company now had two suits on their hands for accidents, one because the cars were not equipped with dead blocks, and the other because they were. Evidence of brakemen seem to show that they considered cars equipped with the dead blocks decidedly safer to couple than those without.

The discussion of the second question was of the most desultory character, and nothing of importance was brought out.

Regarding the third topic, there seemed to be an opinion favorable to the use of the tail bolt rather than the yoke. Mr. Smith, of the Union Tank Line, stated that his company had a large number of cars equipped with tail bolts in which there were two keys made of malleable iron, and that they had never had a breakage, but on cars where the bolt was headed trouble was frequently experienced by the head breaking off or pulling through. The Western lines seem to be favoring the yoke. Attention was also called to the fact that the difficulty with the tail bolt might lie in the method of heading them. If the metal is not hot enough to flow readily in the die, and the man who is doing the work is on piece work, there is apt to be a straining of the metal under the head, resulting in a crystallization, which will shortly produce a fracture, and such crystallization is always found where the heads are broken off, a thing commonly occurring on bolts of 2¼ in. in diameter.

Regarding the fourth question, it was answered most decidedly in the negative as far as there being any real spark arrested, but it was agreed that the extension front itself did efficient work; and there is probably no doubt that it has an advantage over the diamond stack in that the exhaust nozzle is above the netting, and the fire is not torn up as much as with the older appliance.

The general sentiment seems to be that the extension front with a brick arch in the fire-box was the most effective of spark arresters. It was stated that many English engines are running without any netting whatever; and Mr. Dixon cited an instance where an engine on the West Shore road that had originally been fitted with an extension front was run for some time, owing to an accident, with an open stack and no netting or diaphragm in the smoke-box. The result of this, however, was that the machine threw the sparks very badly.

Various methods were suggested for increasing the size of driving-boxes lengthwise. One was to hang the springs from underneath, so that they could be brought central, and another was to use a saddle with a wide leg on one side, so that the spring could be drawn more nearly central with the box than is possible when placed centrally over the frame, and the box is lengthened toward the inside of the engine. The matter of materials for the driving-box was incidentally touched upon, and brought out the fact that solid brass boxes or cast steel were considered far preferable to those of cast iron.

Boston Society of Civil Engineers held their regular meeting on Wednesday evening, January 25.

Mr. Edward P. Adams read a paper on the Light-House System of the United States. The paper covered in a very comprehensive manner the history and theory of lighting our coast and the present organization of the system. The paper was illustrated by drawings and photographs of the various forms of light-houses, beacons, buoys, sirens, etc.

American Society of Civil Engineers.—At a meeting of the Society, held on February 1, a paper was read by Robert Cartwright on the Construction of the Power-House of the Rochester Power Company, adjacent to Genesee Falls, Rochester, N. Y.

The Genesee River drains an area of about 2,500 square miles, and at times pours a flood over the Falls in the city of Rochester, with a volume 293 ft. wide and 5 to 6 ft. deep; the perpendicular fall being 90 ft. By a series of dams the water is used four times before it reaches the level of Lake Ontario.

The paper describes the construction of a power-house close to the Falls, where the great scour made it impracticable to use a timber coffer-dam. This scour was increased by a wing-dam above the Falls, which turned the water toward the side where the power-house was to be built. The rock at the site was undercut by the action of the water, and the first operation was to blast off the overhang to a batter of 1¼ in 10. Operations were carried on day and night, from early in 1890 to November, 1891 (except in freezing weather), since which time the water power has been in use.

The plant consists of two double Leffel wheels, 26¼ in. in diameter, each supplied by a 5-ft. flume under an effective head of 87 ft., with a volume of 6,250 cub. ft. of water per minute, and a development of 600 H.P. by each. The wheels are of phosphor bronze and tinned Otis steel buckets. The power is transmitted from a 5-ft. rope-wheel to a 12-ft. rope-wheel 90 ft. above, through sixteen 1⅛-in. Manilla ropes. The ropes are adjusted by a tightener wheel in an adjustable frame. Each wheel has its own flume and gate, and can be used independently. The ropes run at the very high speed of 7,540 ft. per minute, and no delay has occurred in over a year's use.

The rock at top of the Falls, which is an easily disintegrated shale, overhangs some 20 ft., and the pool below is 40 to 50 ft. deep. The depth at the northwest corner was 10.7 ft., and 13 ft to the northward 22 ft. deep, giving a slope of 45°. The river sometimes rises to half flood in 24 hours, and sometimes when no rain has fallen at Rochester.

A timber coffer-dam in such a location was not to be thought of; and after careful consideration it was decided to use the rock blasted from the overhang above to fill up the pool below. A mass of stone blocks was thus raised 12 to 15 ft. above water and extending outside the foundation. Pumps with 4 and 6-in. suction pipes were used to lower the water. At the point where the solid rock was highest the *débris* was then removed, level benches cut, a heavy footing course laid in Portland cement mortar, and the masonry carried above high water. More broken rock was then removed for about 8 ft. further out, and the irregular spaces filled with dry cement mortar in bags trodden into place. The benching was then done, and the same process followed. By this method, which exposed only a small surface at any one time, all the footings were finally put in and the wall carried above water level.

The cost was less than that of a coffer-dam, even supposing the latter practicable. Stones of 1 to 2 cub. yds. were carried away by the current.

The second paper of the evening was by James Duane, on The Effect of Tuberculation on the Delivery of a 48-in. Water Main. In 1880–81 the writer laid a 48-in. main in Tenth Avenue and Eighty-fifth Street, New York, for the purpose of diverting a part of the flow of the aqueduct into the old Receiving Reservoir in Central Park. This line started from Ninety-third, and ended at the gate-house in Eighty-fifth Street near Eight Avenue.

In 1871–74 the old aqueduct in Tenth Avenue, between Ninety-third Street and One Hundred and Thirteenth Street was replaced by six lines of 48-in. pipe. These mains were all laid true to grade and with curves of 50 ft. radius. At the junctions with the masonry they had converging mouthpieces. They were, however, for some reason, laid without the coal-tar coating now universally applied. The writer, in making the connection of the line laid in 1881 with one of the old mains at Ninety-third Street, found the latter to be tuberculated to a surprising extent. These tubercles were all of the same general shape—that of roughly formed frustra of cones, with a diameter of base of two or three times their height. The largest, which were 2 or 3 in. in diameter and 1 in. high, were, as a rule, found near the bottom of the pipe, but the interior was nearly covered by them.

Bench marks were established on the cover of each man-hole and joined carefully by levels, so that direct measurements could be made to the surface of the water, and thus establish its level above datum. As the quantity of water discharged was at this time very uniform and was accurately known, the value of C in the formula $V = C, \sqrt{R, I}$ could be quite closely determined. In the aqueduct a value of $C = 135$ gives satisfactory average results, and the flow at this time was 96,000,000 galls. per day. Part of this flow was withdrawn at points above, and a net flow of 92,500,000 galls. per day entered the Tenth Avenue mains, making 18,500,000 galls. for each main. The observed loss of head in a length of 5,992 ft. was 3.39 ft., giving C the remarkably low value of 96, or about 30 per cent. less than that assigned to it in modern practice.

After connections were made between the most westerly of the old pipe and the new pipe laid in 1881, there was a continuous line of 48-in. pipe, of which 5,306 ft. were tuberculated and 4,123 ft. were clean. The observed loss of head in the first was 1.86 ft. and in the second 0.74 ft.; in other words, the value of I in the first was .00035 against .00018 in the second, or about double. Taking C in the first at 96 gave 14,500,000 galls. per day discharge, and this in the new main using I, as determined by observation, gave $C = 134$.

Eleven years later the new main was free from tubercles, and observation showed its discharging capacity unimpaired.

The conclusions are that Croton water will cause bad tuberculation in an uncoated pipe in seven years; that after a cer-

tain time this deterioration does not seem to increase; that a loss of 30 per cent. in discharging capacity is occasioned by the absence of tar coating; or, in other words, that such a coating is worth about $20,000 per mile.

Finally, that after 11 years' service tar coating seems to have perfectly protected the new main from tuberculation.

The Engineering Association of the South held a January meeting at Nashville, Tenn., on the evening of the 12th.

Major W. F. Foster presented a description of the development of the water power at Estill Springs, Tenn. At this point Ell River makes a bend, returning on itself after flowing several miles, the neck of land between the two portions being only 300 ft. across, with a difference of elevation of 12 ft., which is supplemented by a masonry dam raising the water above the bend an additional 12 ft. Across the neck of land a canal is cut which provides for the fore-bay, the wheel-pits, and the tail-race. The power-house of the mills that are to be driven by the power is placed over the wheel-pits. The dam is 300 ft. long between abutments, 5 ft. wide on the crest, is trapezoidal in cross-section, vertical on the upstream side, and battered 6 in. per foot on the down-stream side. It is bedded throughout on solid rock. The masonry is heavy, random, coursed work, laid throughout in hydraulic cement mortar, with a portion of the down-stream stones in each course dowelled to the course below.

Civil Engineers' Club of Cleveland.—At the February meeting Mr. Herman read a paper on "A Weldless Chain," in which he said:

"Oval link welded chain, as used in ship cables for hoisting, is produced in almost the same manner as it has been for several centuries past. Few and but slight improvements have ever been introduced in this industry. Devices intended to supplant this class of chains have never succeeded, for all sacrifice the flexibility at every joint possessed by the ordinary chain. The new chain invented by the writer consists of links each formed of four separable parts—two side-bars and two end pieces. The latter are provided with suitable threaded cavities to receive the screw ends of the former. The links so constructed possess the flexibility of the common chain to the fullest extent. Material and form of each part are selected with regard to the work they have to perform in practical use, while the proportions at each point are determined by the most careful calculation. In this way a link is produced that fulfils all the theoretical and practical requirements of a perfect chain, and is, at the same time, free entirely from the uncertainty of the weld. The different sizes of this chain will be introduced by indicative numbers. These will convey full information as to strength, safe load, and pitch of each size. The chain will be produced ready for use by means of automatic machines invented by the writer. Under the most trying tests this chain has proved its strength and reliability."

JOHN ORTTON.

The reference to the serious illness of Mr. Ortton, which was published in the January number of this Journal, must have prepared those of his friends who read it for the sad news of his death, which occurred on January 6, at his home in Frankfort, Ind.

He was born at Nottingham, England, on March 11, 1825. In March, 1838, he was apprenticed to Mr. William Burlinson, of Sunderland, to learn the trade of a millwright and mechanical engineer. In 1844 he was employed as a fitter in the locomotive works of Robert Stephenson & Company, at Newcastle-on-Tyne. It was at the time that he was working in this shop that his friend, Mr. Williams, invented the link motion. Mr. Ortton wrote an account of this, which was published in the *Railroad Gazette* of Feb. 4, 1881.

In 1847 he was employed in the locomotive department of the London & Northwestern Railway, at Wolverton, in Buckinghamshire. In 1851 he went to the Eastern Counties Railway at Stratford, near London. In 1857 he was engaged as Foreman of the locomotive and car department of the Londonderry & Enniskillen Railway, at Londonderry, in Ireland. From there he went back to the London & Northwestern Railway, as Locomotive Foreman, at Wolverton. This was in 1861. In 1864 he was engaged as Foreman of iron works at Newton Heath, near Manchester, England. In 1865 he was engaged as Manager of the locomotive works of George England & Company, at Hatcham, New Cross, London. Two years afterward he became Manager of the locomotive shops of the London & Southwestern Railway, at Nine Elms, London.

In September, 1873, he left England to take the position of Assistant Mechanical Superintendent of the Great Western Railway of Canada, at Hamilton, Ont., where he arrived on September 16, 1873. Two years after he was appointed as Acting Mechanical Superintendent of the same road. He held this position for one year, and then received the appointment of Mechanical Superintendent of the Canada Southern Railway, with headquarters at St. Thomas, Ont.

In June, 1882, he was appointed General Manager of the Portage, Westbourne & Northwestern Railway, then under construction, with headquarters at Portage, La Prairie, Manitoba. A severe sickness led him to resign this position in 1883, and he then returned to St. Thomas.

In the June following he was appointed Master Mechanic on the New York Central & Hudson River Railroad, in charge of the shops at West Albany. He occupied this position for five years. In the beginning of 1888 and the year following he was engaged as Superintendent of Construction by the American Live Stock Express Company, and was employed by various roads and persons as an expert on special work of various kinds. In May, 1890, he was appointed Superintendent of Motive Power and Rolling Stock of the Toledo, St. Louis & Kansas City Railroad, with headquarters at Delphos, O., but soon after new shops were built for the road at Frankfort, Ind.; he removed his office to that place.

About the first of last November an organic complaint, with which he had been suffering for several years, became worse, and he was obliged to give up all work. The best medical attendance was procured, and hopes were entertained by his friends and family that he would recover; but with the most acute suffering his vitality left him, and he gradually sank and never rallied. His body was taken to St. Thomas, Ont., for burial. He leaves a wife and six children—four daughters and two sons.

Mr. Ortton was an active member of both the Master Mechanics' and the Master Car-Builders' Associations. His genial and pleasant nature made him a general favorite there, and he was popular wherever known. His career is an example of the frequent changes which come to many a man, through no fault of his own, who is engaged in the very uncertain occupation of railroading. Mr. Ortton's career was one of steady advancement, excepting, perhaps, during the last few years of his life, when he bore the burden of ill health. In announcing his death, Mr. Callaway, the President of the company by which he was employed, said of him: "He was a faithful and efficient officer and a fearless and incorruptible man. After life's fitful fever he sleeps well."

His fellow-members of the two associations referred to, especially the older ones, will sadly miss his genial presence, his jovial manners, his sincere, frank, honest nature at their yearly reunions.

PERSONALS.

H. F. Sockridge has been appointed Master Mechanic of the Columbus, Hocking Valley & Toledo Railroad, with headquarters at Columbus, O.

H. A. Gillis has resigned as Master Mechanic of the Port Jervis shops of the New York, Lake Erie & Western Railroad, to become Superintendent of the Roanoke Locomotive & Machine Works at Roanoke, Va.

J. J. Frey has resigned as General Superintendent of the Missouri, Kansas & Texas Railroad to become Vice-President and General Manager of the East Line & Red River Railroad, with headquarters at Greenville, Tex.

A. H. Rudd has been appointed Superintendent of Signals on the Hudson River Division of the New York Central & Hudson River Railroad.

Edgar Van Etten, Superintendent of the Rome, Watertown & Ogdensburg Railroad, has been appointed General Superintendent of the New York Central & Hudson River Railroad instead of Theodore Voorhees, who has resigned.

W. Howard White, C. E., formerly of 74 Wall Street, New York, announces that he has found it expedient to move with his family to a milder climate, and has taken up his residence at Redlands, San Bernardino County, Cal., which will be his future address.

A. A. Allen has been appointed General Superintendent of the Missouri, Kansas & Texas Railroad Company, in place of J. J. Frey, resigned.

Joseph S. Harris has resigned the Vice-Presidency of the Philadelphia & Reading Coal & Iron Company. The resignation was due to the fact that in compliance with the orders of the Chancellor of New Jersey the lease of the Central Railroad

to the Port Reading Railroad was recently dissolved and the managers of the former road have resumed the control.

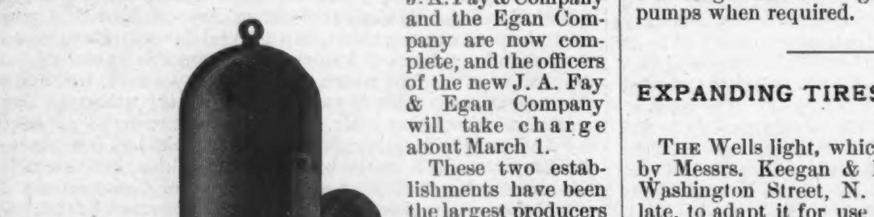
GENERAL SUPERINTENDENT THEODORE VOORHEES, of the New York Central, has resigned to take the position of First Vice-President of the Philadelphia & Reading. Mr. Voorhees began his railroad work in 1869 in the engineering department of the Delaware, Lackawanna & Western, remaining in that branch of the company's service for about four years. He was then for two years Superintendent of the Syracuse, Binghamton & New York. In December, 1874, he became connected with the transportation department of the Delaware & Hudson Canal Company, and for ten years, up to October 20, 1885, was Superintendent of the Saratoga and Champlain divisions of that company. He left that position to become Assistant General Superintendent of the New York Central, being made General Superintendent at the time MR. TOUCEY was promoted to the position of General Manager.

General Notes.

The Indiana Car & Foundry Company held its annual meeting February 7. The financial office of the company is in Cincinnati. Large contracts for cars have been taken, amounting in the aggregate to over $1,000,000. Among these are coal cars for the Pennsylvania Railroad, World's Fair passenger cars for the Illinois Central Railroad, and improved cattle cars for the Hicks Stock Car Company. The works now give employment to about five hundred men, which will be increased to about eight hundred during the next sixty days.

Consolidation of the J. A. Fay and Egan Companies of Cincinnati.—The negotiations that have been in progress for some time for the consolidation of the two great companies of J. A. Fay & Company and the Egan Company are now complete, and the officers of the new J. A. Fay & Egan Company will take charge about March 1.

These two establishments have been the largest producers of wood-working machinery in the country, and heretofore have been the sharpest of business rivals. The new company will probably be the largest of its kind in the world. The directors of the new company will be Thomas P. Egan, Frederick Danner, W. H. Doane, D. L Lyon, David Jones, W. P. Anderson, Joseph Rawson, S. P. Egan and Edwin Ruthven. Thomas P. Egan will be President and the soul of the enterprise, as he has been of the old Egan Company; Mr. Danner will be Vice-President, S. P. Egan, Superintendent and Mr. Ruthven, Secretary. These four officers are of the Egan Company.



Manufactures.

The Standard Fire Pump.

THE pump illustrated is one made by Dean Brothers' Steam Pump Works, Indianapolis, Ind., and is constructed from new patterns throughout, in order to conform to the demands of the Associated Insurance Companies for a special fire pump for use in mills, factories, and public buildings, where the premium on insurance risk is based upon the completeness of fire protection furnished by the insured.

These pumps are made strictly in accordance with the specifications adopted by the committee, and are made in four sizes varying in capacity from one stream delivering 320 galls. per minute to four streams delivering 1,000 galls. per minute. They are made of first-class material, and finished and tested to a maximum pressure of 320 lbs. to the square inch at the water end before leaving our works. They have bronze water-piston heads and followers, bronze removable liners in the water cylinders, Tobin bronze piston-rods and valve-rods, bronze, or bronze-lined stuffing-boxes, cushioning valves in steam cylinders, a capacity plate, a stroke gauge, a steam-pressure gauge, a water-pressure gauge, a vacuum chamber, a water-relief valve of large capacity, a set of brass priming pipes and valves, from two to four Chapman hose-valves, and a sight-feed lubricator. The water cylinders have three suction openings. They have large water-valve area, large steam and exhaust passages, suction pipe connections and air chamber.

They are designed for stationary fire-engines, and are reliable, and can be operated at a high rate of piston speed without danger of breaking. A regulator is furnished with the pumps when required.

EXPANDING TIRES WITH THE WELLS LIGHT.

THE Wells light, which has been introduced to this country by Messrs. Keegan & Halpin, now William Halpin, of 44 Washington Street, N. Y., has been somewhat modified of late, to adapt it for use in locomotive work for taking off and placing locomotive driving-wheel tires. The construction and action of the lamp, with which our readers are already familiar, have been left unchanged. For the purpose of concentrating and holding the flame down to the tire the apparatus shown by our engravings has been designed. It consists of a sectional covering (Figs. 1 and 2) which, resting upon the flange of the wheel, clasps the tire on either side, and is so constructed that it can be applied to wheels of any diameter, the total length of the section being increased or diminished by the clamps which hook into the slotted sides as shown in the engraving. In this way a single set of sections can be used on wheels varying from 48 in. to 84 in. in diameter. It is simply necessary to jack up the wheels and drop the sections in place.

In regard to the lamp, there have been a few minor changes; in order to make it suitable and convenient for use in connection with this work, instead of the usual upright pipe, carrying the burner at its upper extremity, which throws out the long horizontal flame, the pipe between the tank and the burner is provided with a number of joints, which may be slackened off and tightened so that the burner is readily adjustable and can be held rigidly in any position which may be desired. The burner itself is carried on a pipe turned and fitted to pass through a stuffing-box, so that it may be moved somewhat after the regular pipe fittings have been set; and this stuffing-box is still further fastened by a clamp setting firmly down upon it. The modification in the burner consists in adding one square coil, making three in all, through which the oil (kerosene of 150° fire test) is compelled to pass, and where it is completely volatilized on its way to the burner. One burner remains the same as the regular lighting lamp; the other, where the burner is turned down, has a pipe ex-

tending from the jet end and communicating with the jet itself to the farther coil of the burner; hence, all oil which reaches the jet must rise to the top and come down through this tube, thus insuring its perfect volatilization.

When the apparatus is in use the wheel is entirely surrounded with a sheet of flame; and it is claimed that the tire is more uniformly heated by this method than where a jet of gas is used, because in this instance the flame covers the whole tread of the wheel, and the heat works uniformly inward, so that the center does not receive very much heat, whereas with gas the impingement of the hot Bunsen flame against the center of the tread makes it necessary that the heat should be carried by connection to the farther corners, so that the probabilities are that the center of the inner surface of the tire is heated more rapidly than the corners or the flange, and, consequently, the tire remains for a longer time in contact with the center, which, therefore, receives a greater portion of heat.

A test was made before a number of railroad men and representatives of the technical press at the Kingsland, N. J., shops of the Delaware, Lackawanna & Western Railroad, on February 15. The first four tests consisted in removing the tires from driving-wheels having 57½ in. centers, the tires being 1¾ in. thick. The two lamps used were carefully weighed before lighting, and found to weigh 285 lbs. and 280 lbs. respectively. The blaze was turned at 11.36 in the morning, and four minutes later the lamps were adjusted to the tire. In ten minutes the tires had been expanded .08 in. in diameter, and the lamps were removed. In five minutes more the tire had been swung clear of the wheel and was on its way to the scrap heap. In the second test the lamps were burning in contact with the tire for 14 minutes, and the tire was off 3½ minutes later. The third test the lamps were burning for 12 minutes, and 2½ minutes more were required for the removal of the tire. The fourth test occupied 12 minutes for heating and 2½ minutes for

THE WELLS LIGHT AS USED FOR EXPANDING TIRES.

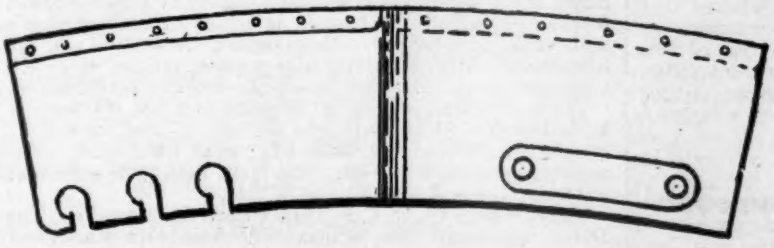


Fig. 1.

Scale. 2" = 1 Ft.

Fig. 2.

the removal of the tire. The last tire was removed in just exactly 61 minutes from the time of the application of the first lamp to the first tire, thus finishing at the rate of about four tires per hour.

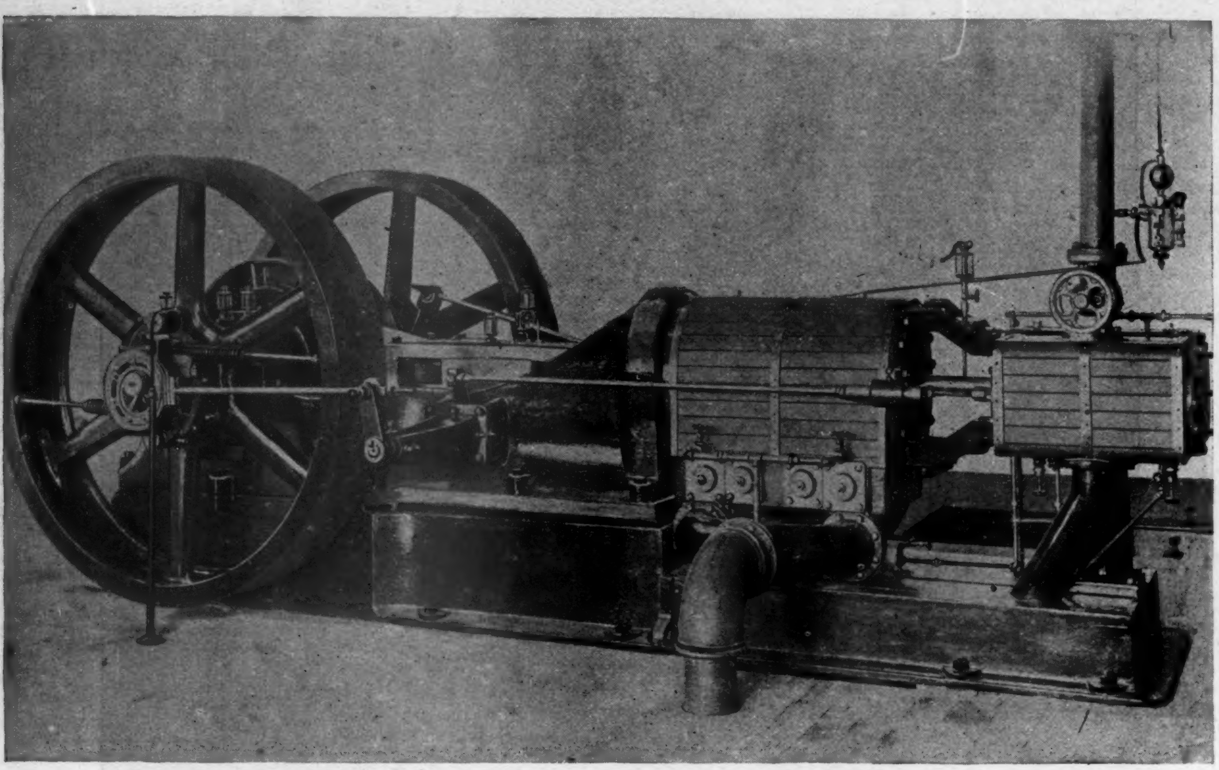
The next two tests were those of heating tires for application to wheels of 44-in. centers, the tires themselves being 3½ in. thick. These were also expanded so that their diameter was increased .08 in. The lamps were burning against the tire for 11 minutes, and 2 minutes were required for the adjustment of the tire. In the second instance the lamps were burning for 10 minutes, and the tire was in position 2 minutes later. The apparent reason for the greater length of time required for heating the third and fourth tires over the first, fifth and sixth lies, probably, in the fact that when the first named were reached the tank pressure had fallen from 25 to 20 lbs., and was again pumped up to 25 lbs. before doing the work on numbers five and six. After the tests the tanks were again weighed, and it was found that one had consumed 47 and the other had consumed 41 lbs. Taking the oil as weighing 6½ lbs. to the gallon, we have a total oil consumption for the 88 lbs. of 13.5+ gallons. It must be taken into consideration, however, that whereas both lamps were burning for 2 hours and 30 minutes, there was an interval of 40 minutes between tests four and five, when no work was being done. So we have the oil consumption in actual service reduced to 64½ lbs., or 9¾+ gallons. As this oil costs six cents a gallon, the cost for heating the six tires is 58½ cents. The temperature of the flame has not been accurately determined as yet, but it is believed that it is sufficiently high to heat locomotive flames for straightening while still in position upon the engine, and work of this kind will be attempted very shortly. The expansion of the tire for the 44-in. center by .08 in. shows an increase of temperature of about 205°.

ARMINGTON & SIMS' TANDEM COMPOUND ENGINE.

Among the large variety of engines turned out by the Armington & Sims Engine Company the tandem compound, herewith illustrated, is meeting with great success, particularly for the heavy, variable duty of the electrical railroad service. These engines are built very heavy—large shafts, wearing surfaces ample, heavy balance wheels, and, in fact, every part is designed especially for the hardest duty.

The particular engine illustrated above is one of two in use by the Worcester & Millbury Railroad, and is of 250 H.P.; cylinders, 13 in. and 24 in. × 18 in.; speed, 200 revolutions; wheels, 86 in. in diameter. It has a steam-jacketted receiver, and the high-pressure cylinder is also steam jacketted. It is self-contained, having a base under engine which is extended to support the cylinders. The low-pressure cylinder has four Corliss valves worked by a very simple and efficient device.

The company is now building engines of this type from 150 H.P. to as large as 900 H.P. The details of these engines seem to be particularly well worked out, and it is useless to speak of the workmanship, as this company aim to furnish nothing but the best. The Jarvis Engineering Company of 61 Oliver Street, Boston, Mass., are the Eastern agents for the sale of the Armington & Sims engines, as well as contractors for complete steam plants.



ARMINGTON & SIMS' TANDEM COMPOUND ENGINE.

AN ENGLISH LOCOMOTIVE FOR SUBURBAN TRAFFIC.

The accompanying illustration, from the London *Engineer*, shows a tank engine for suburban and mixed traffic built for the London, Tilbury & South End Railway on the designs of Mr. Thomas Whitelegg, Locomotive Superintendent. It has four driving-wheels coupled, and all placed under the barrel of the boiler; the front end is carried by a four-wheeled truck, and behind the fire-box is a pair of bearing wheels with radial axle-boxes. The cylinders are outside and are horizontal. Water is carried in two side-tanks, and there is a small tank on the foot-plate, where the coal-box is also placed.

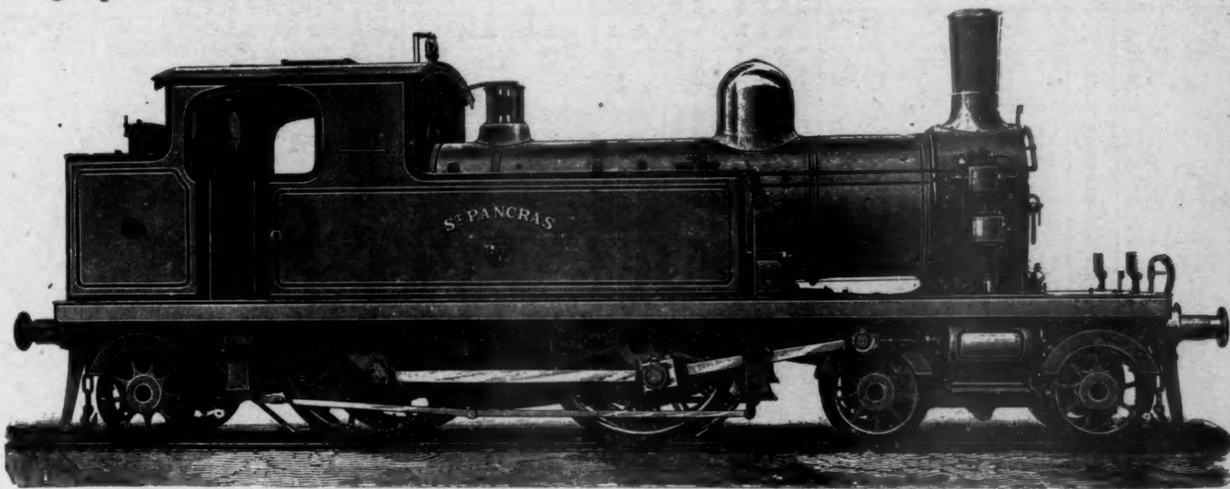
The boiler barrel is 49 in. in diameter and has 189 tubes 1⅝ in. in diameter. The grate area is 17 sq. ft., and the heating surface is: Fire-box, 97; tubes, 914; total, 1,011 sq. ft. The working pressure is 160 lbs. The tanks hold 1,300 gallons of water and the coal box two tons of coal.

The cylinders are 17 in. in diameter and 26 in. stroke. The driving-wheels are 73 in. in diameter. The truck wheels and the trailing wheels are 37 in. in diameter. The steam-chests are on the inner sides of the cylinders, in the smoke-box. The frames are of the usual English plate type. The driving wheel-base is 8 ft. 6 in, and the total wheel base 29 ft. 4 in.

The total weight of the engine in working order is 126,350 lbs., of which 36,250 lbs. are carried on the truck, 71,850 lbs. on the driving-wheels and 18,250 lbs. on the trailing wheels. The engine is fitted with the Westinghouse air-brake and has driver-brakes.

Band Resawing Machine.

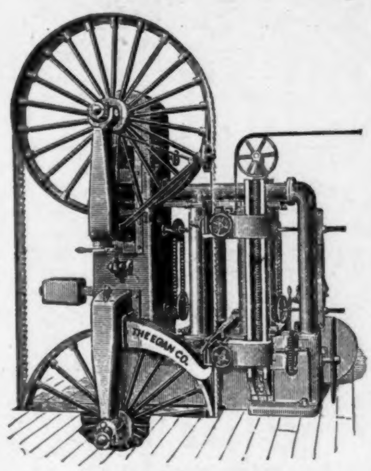
WE illustrate a new band resawing machine with a capacity of 35,000 ft., made by the Egan Company, of Cincinnati, O. It is easy to handle and not liable to get out of order, and can be run in a saw-mill in connection with a band saw or with a circular, using the circular for squaring up the logs and reducing the timber to boards on the resaw.



ENGLISH TANK LOCOMOTIVE FOR LOCAL TRAFFIC.

The wheels are 80 in. in diameter, of solid metal, having steel spokes placed in the hub and rim in such a position as to insure the greatest amount of strength. Each wheel is fitted to its shaft in a superior manner, perfectly balanced; the lower wheel being made thicker and heavier in the rim is given thereby an increased weight and momentum, and is an improvement of more than ordinary value. Each wheel shaft is supported by an adjustable outside, heavy bearing outside of each wheel.

The feed is very powerful, consisting of two pairs of feed rolls of large diameter and driven by powerful gearing; each pair of feed rolls is operated independent of the other, and supported at the top and bottom by large screws, making it impossible for the rolls to get out of line with the saw when sawing warped or irregular stock. The graduating feed is at all times under control of the operator, enabling him to increase or diminish it by moving one lever.

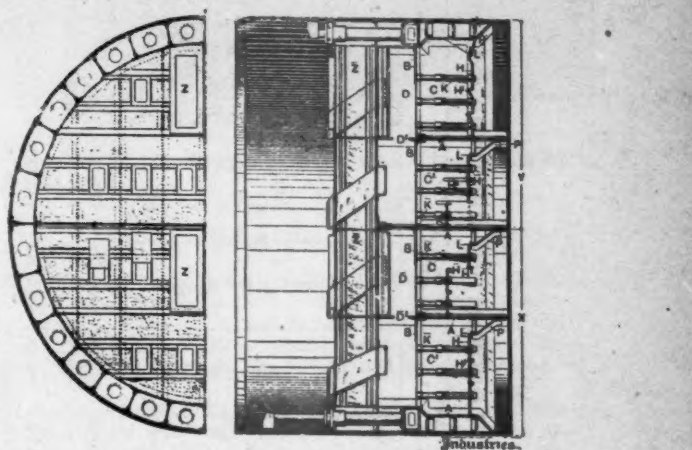


EGAN BAND SAW.

The roller guides are of new design, and the upper guide is connected to an upright bracket moving up and down on same and counter-weighted. It will resaw stock up to 48 in. wide and to the center of 24 in., or will cut a thin sheet or board from the side of a timber 12 in. thick. When cutting narrow stock, the entire width of cut can be made by placing several pieces of stock between the rolls, one above the other.

A NEW TUNNELING SHIELD.

THE accompanying cut shows a form of tunneling shield recently patented in England by G. & W. D. Pearson, of Westminster. These inventors aim at constructing tunneling shields for use in tunneling through water-bearing strata in such a manner as to provide for the men working in safety in case of an inrush of water, to prevent the lining becoming displaced before or during the process of filling up between it and the tunnel, and to provide for the process of excavating to be carried on in stages, in each of which the work is done vertically. Fig. 1 shows a half elevation of the shield looking from the tunnel, and fig. 2 is a longitudinal section of the same. The shield itself is, as regards its outer formation and as regards the method of driving it forward, of the same construction as those heretofore employed. *A A* are transverse floors of any number, fitted equidistant apart and dividing the interior of the shield into any number of compartments, and *B B* are hanging curtains, the space in front of which forms the working chambers *C* C^1, while behind these chambers are safety chambers *D*, arranged alternately behind the former. The man in the lower working chamber of each pair has always, when there is an inrush of water, an air space in front of the curtain *B*. A way, D^1, is cut in the floor of the safety chamber above him for him to climb up through, and a suitable doorway, *E*, is provided through which the workmen can escape into the air-lock *Z*. This door-



PEARSON'S TUNNELING SHIELD.

way is at a sufficiently low level to leave head-room and a breathing space of sufficient capacity to prevent his being drowned by the water, which latter will be kept back by a volume of air in the safety chamber, the pressure of which will equal that of the water. The front of each working chamber is made up with pollings or shutters *H*. These are of any convenient cross-section, carried by a suitable number of rams *K* or screws, and are supported from behind in any convenient way. The adjacent edges are provided with suitable packings H^1. H^2 are flexible webs made of sail canvas, rubber or other material. The bottom edge of the lowest polling in any one compartment may be made practically water and air-tight by flexible rubber flaps, or other suitable device, or by clay packing. A flap, *L*, is hinged to the top of the shutter in such a way that it can be pushed outward and downward by the man so as to give him free access through the excavating opening to the stuff to be got out and also to act as a water

LOCOMOTIVE RETURNS FOR THE MONTH OF NOVEMBER, 1892.

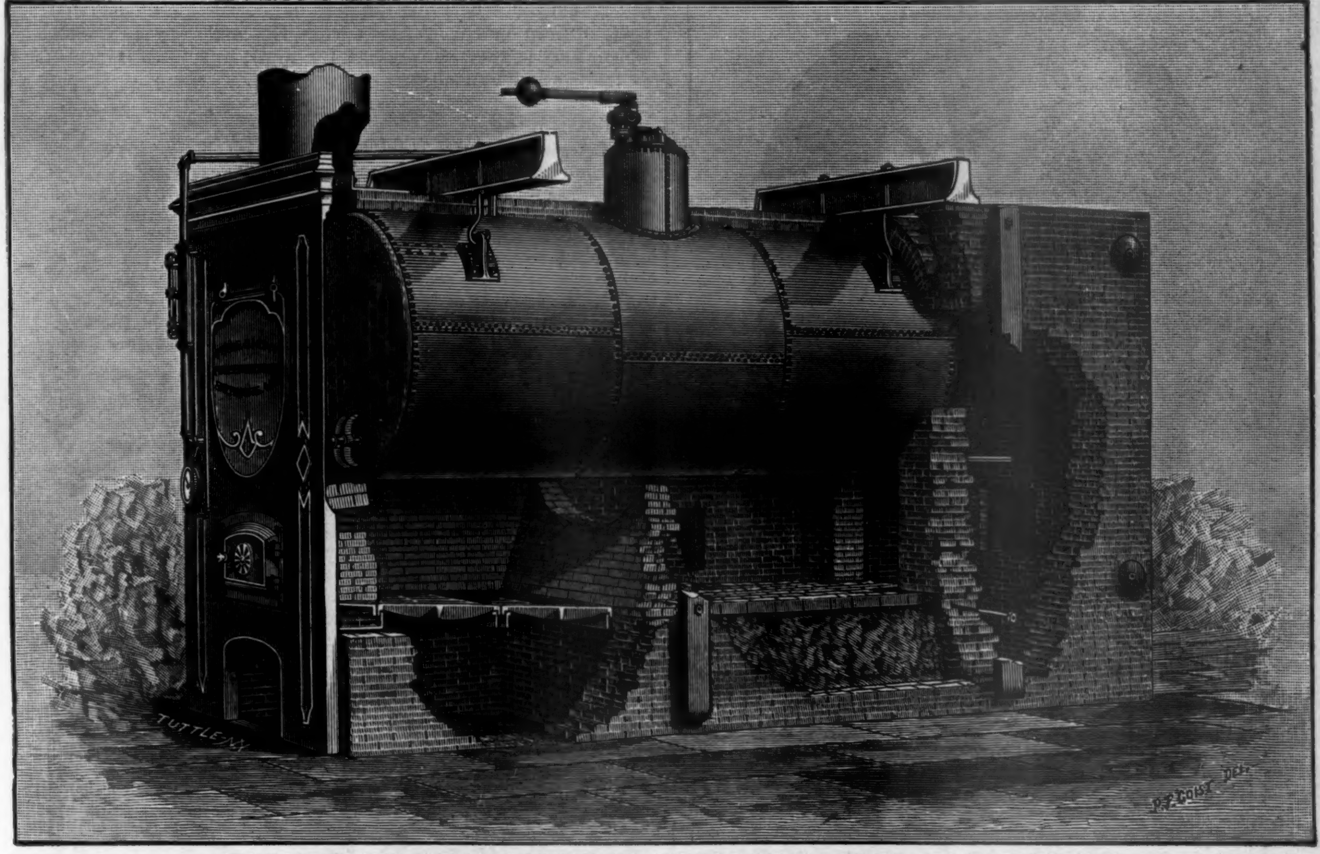
Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage.					Av. Train.		Coal Burned per Mile.						Cost per Locomotive Mile.							Cost per Car Mile.		Cost of Coal per Ton.
			Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Passenger Cars.	Freight Cars.	Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Passenger.	Freight.	
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Atchison, Topeka & Santa Fé	834	739	....	....	401,701	2,312 940	3,130	....	....	...	....	...	87.26	...	...	4.91	6.73	0.27	0.14	6.79	1.50	20.34	....	...	1.48
Canadian Pacific*	606	....	466,782	825,779	515,889	1,808,445	2,984	....	....	....	....	...	72.28	....	....	3.40	12.21	0.39	....	5 38	1.24	22.62	...	1.96	3.35
Chic., Burlington & Quincy	528	....	....	....	....	1,814,281	3 436	4.87	18.54	....	....	...	90.86	....	...	4.82	6.29	0.23	0.30	6.74	....	17.88	....	...	1.39
Chic., Milwaukee & St. Paul	....	....	....	....	....	....	..	....	....	...	....	....	...	....	...	....	....	...	...	....	....	....	....	...	....
Chic., Rock Island & Pacific	553	....	548,181	982,393	409,242	1,939,816	3,508	....	..	....	....	....	68.89	...	.	2.75	6.53	0.22	2.75	6.02	0.42	15.94	....	....	1.64
Chicago & Northwestern	888	....	686,188	1,451,416	789,136	2,926.740	....	....	...	....	...	....	88.41	....	....	3.35	7.94	0.34	....	6.37	0.83	18.83	....	....	1.78
Cumberland & Penn	22	22	5,259	39,610	....	44,869	....	....	...	....	....	....	90.09	...	....	4.07	4.84	0.40	....	...	....	....	...	....	1.83
Delaware, Lackawanna & W. Main L.	208	193	....	....	....	680.701	3,527	...	....	....	...	....	92.72	...	....	2.97	7.30	0.42	...	5.81	....	16.50	...	...	....
Morris & Essex Division	159	..	166,857	231,862	12,523	411,242	2,586	....	...	...	....	....	64.43	....	...	4.14	10.12	0.39	....	6.42	...	21.07	....	....	3.09
Hannibal & St. Joseph	....	69	74,461	160,552	36,567	271,580	4,115	5.41	16.42	....	....	....	97.28	14.73	7.71	4.01	6.88	0.24	0.30	7.01	....	18.44	....	....	1.44
Kansas City, F. S. & Memphis	149	....	98,569	262,926	124,384	485.879	3,260	....	....	...	...	....	66.64	....	...	3.21	5.44	0.23	0.48	7.34	....	16.70	...	....	1.60
Kan. City, Mem. & Birm	41	37	35,355	62,890	12,098	110,340	2,982	....	...	...	....	....	65.55	....	....	2.44	3.71	0.24	0.49	7.(6	....	13.94	...	....	1.08
Kan. City, St. Jo. & Council Bluffs	41	....	57,545	41,457	43,868	142,870	3,485	5.00	21.78	....	....	....	66.49	13.35	4.74	2.21	6.38	0.14	0.31	5 97	....	15.01	....	....	1.95
Lake Shore & Mich. Southern	589	....	426,934	849,043	625,968	1,901,945	3,229	....	....	....	....	....	....	....	....	3.02	5.32	0.13	0.50	6.97	0.18	15.67	...	....	1.54
Louisville & Nashville	346	....	416,706	850,624	398,793	1,666,123	3,663	5.11	18.77	68.58	116.51	52.66	...	13.50	5.97	4.23	7.00	0.26	0.85	6.11	0.57	19.57	3.36	1.26	1.59
Manhattan Elevated	....	292	744,504	....	53,266	797,770	2,732	....	...	....	....	...	46.13	....	....	2.30	9.20	....	0.30	8.80	....	20.60	...	....	3.99
Mexican Central	....	....	....	....	....	....	...	....	...	....	....	...	....	....	....	...	...	....	...	....	....	....	...	....	....
Mil., L. S. & Western	....	112	76,940	133,715	76,121	286.776	2,578	....	....	...	....	....	79.33	....	....	3.44	11.29	0.25	....	6.23	0.97	22.18	....	....	2.80
Missouri Pacific	339	313	....	....	....	1,187,357	3,787	4.48	16.99	....	....	....	80.67	15.55	6.88	5.37	6.50	0.33	1.09	6.42	1.47	21.18	4.42	1.46	1.42
N. Y., Lake Erie & Western	...	623	445,642	924,921	291,042	1,661.605	3,023	4.50	22.70	90.80	134.8	71.20	....	20.10	6.00	4.68	7.59	0.38	2.10	7.30	1.15	23.20	....	1.68	1.36
N. Y., Pennsylvania & Ohio	....	250	132,516	428,439	153,724	714,679	3,455	5.40	18.10	84.20	133.0	79.60	....	15.70	7.30	3.90	6.49	0.30	1.72	6.88	1.02	20.31	....	1.71	1 15
Norfolk & Western, Gen. East. Div.†	....	143	97,936	259,631	57,854	415.421	2,788	4.50	19.00	....	...	....	102.07	....	...	9.00	3.70	0.70	....	...	....	13.40	....	....	....
General Western Division	....	122	68,586	237,609	25,442	331,637	2,632	4.50	14.90	...	....	....	129.03	....	...	13.60	4.50	0.80	....	....	....	18.90	....	....	....
Old Colony	....	226	333,323	129,027	126,281	598,631	2,649	...	....	...	....	....	62.92	...	...	2.88	11.81	0.64	....	6.75	0.79	22.87	...	....	3.75
Philadelphia & Reading	....	....	466,485	828,700	520,444	1,915,629	....	....	....	....	....	....	81.23	....	....	3.72	4.81	0.31	....	6.00	0.39	15.23	...	....	....
Southern Pacific, Pacific System	....	721	....	....	....	1,740,198	2,414	...	....	....	....	....	70.42	...	....	5.02	17.71	0.41	1.71	7.29	1.19	33.89	....	...	5.11
Union Pacific	....	991	698.074	1,583,719	514.812	2,796.605	2,822	5.51	17.46	....	....	....	99.90	....	...	7.04	9.18	0.40	0.84	8.10	1.03	26.59	4.53	1.87	1.82
Wabash	419	362	394,584	687,853	311,900	1,394,337	3,855	5.01	17.55	....	...	....	91.74	14.72	6.41	3.46	4.68	0.30	....	6.37	0.85	15.66	2.65	1.02	1.02
Wisconsin Central	150	123	119,784	236,833	17,095	433,112	3,521	....	....	....	....	....	88.37	....	....	3.83	10.57	0.27	...	7.16	....	21.83	....	....	2.36

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars.

* Switching engines allowed 6 miles per hour; wood, construction and gravel trains, 10 miles per hour.

† Wages of engineers and firemen not included in cost.

seal. The outer edges of the pollings are packed to the sides of the shield in the following way: Chambers are formed around the working chamber of a suitable length to meet the requirements of the travel above mentioned by means of two angle-bars, one *M* fixed to the shield, and the other *N* to the polling. The flange of the angle on the latter, which is next to the shield, rests and slides upon the angle on the shield, thereby closing in the chamber. This is filled with clay or puddle, and as the travel begins the clay escapes through suitable openings, but suffers sufficient compression to insure a tight joint. The leading edges of the floors, as well as the edge of the shield are provided with plows *P* which, as they advance, readily loosen the stuff immediately adjacent to them. The side edges may also be fitted with plow edges if the nature of the soil render such a construction desirable. The shield is subdivided vertically into two or more compartments *X Y*, and these two form two air-tight chambers, into which air can be delivered at a pressure suitable to the hydrostatic head existing in each of the compartments of the shield so subdivided.—*Industries.*



HORIZONTAL TUBULAR BOILER, BY THE ROBERT POOLE & SON COMPANY.

H. K. Porter & Company's Distribution of Profits to Employés.

THIS firm of locomotive builders has recently made the eighth voluntary distribution to their employés. In their circular announcing this distribution, it is said:

"The conditions of business the past year have been very trying, and in many respects discouraging. Prices were less throughout the year than in 1891, and the output for the first six months was very small. But as soon as the demand increased the output largely increased, and by your efficient co-operation, so soon as you had the opportunity to put it forth, we largely recovered the lost ground. This proves to us what we believed before, that practical co-operation is a positive benefit to every one of us, and that it pays us partly, if not fully, in the item of dollars and cents, to make this distribution. We have often said to you that it is only on this basis that we can hope to make such distribution a permanent annual thing. But such reasonable return to us only makes us the more gratified to recognize your efficient and cheerful service, and to be able to give you this additional remuneration for your faithful labor. We hope that in receiving this sum, each one of you is conscious of having deserved it by having rendered the best service in his power; and that the money will be a positive good to each one, and to all dependent upon you.

"Hoping for your individual good in every way in the future, we remain,

"Your friends,

"H. K. PORTER & COMPANY."

Such evidence of amicable relations between employers and their men lead to the thought that the millennium is not an impossible event.

Poole's Horizontal Boiler.

THE accompanying illustration shows a horizontal tubular boiler and setting by the Robert Poole & Son Company, Baltimore. The boiler is given, not so much for any special feature, as to show the excellent arrangement of tubes and the general good proportion of the setting and general arrangements.

The engraving shows the boiler with furnace front and masonry, one of the side walls being removed to show the arrangement of grate bars, bridge walls, damper, tubes, etc. The flame passes under the boiler and returns through the tubes. These boilers are constructed of best materials and workmanship, the tube-sheets especially being of very superior materials, manufactured expressly for the purpose. The tubes are arranged so as to provide for the freest possible circulation of the water, and a manhole is placed in the lower part of the front head, so that the boiler may be cleaned with convenience and thoroughness. The mountings consist of furnace front, grate and bearing bars, flue chamber doors, wall plate, bolts and rods, safety-valve, steam-gauge, gauge cocks, and blow-out and feed cocks.

NAVAL OBSERVATORY TELESCOPE.

THE new telescope for the Naval Observatory at Washington has recently been completed by Warner & Swasey, of Cleveland, O., the builders of the famous Lick instrument. It is entirely new, with the exception of the fine 26-in. object glass, and in power is second only to the Lick in this coun-

try, and is excelled by but two telescopes abroad—the Vienna instrument and the one at Pulkowa, Russia.

The new telescope will weigh 30 tons, about two-thirds of which comes from the cast-iron rectangular supporting pier, in which is built the great clock for driving the telescope in either stellar, solar, or lunar time. By it the star under observation is kept in exactly the center of the field of vision for hours at a time, and it is possible to leave a photographic plate exposed three or four hours with the same results as if the tube and star alike were stationary.

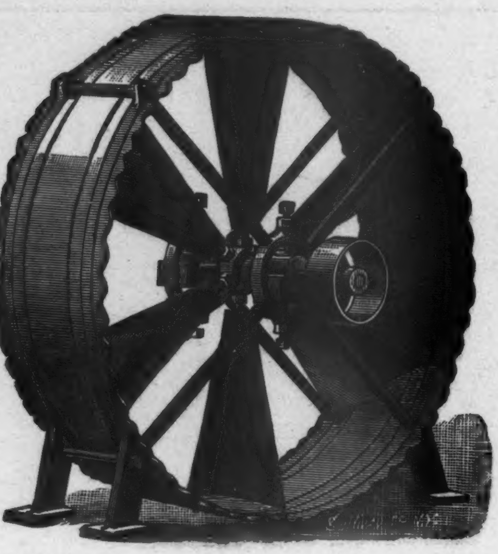


Fig. 1.

The tube itself is of sheet steel, 38 ft. long, 26 in. in diameter at the object glass, 31 in. at the center, and 24 in. at the point where the eye-piece is placed. The sheets vary in thickness from one-tenth to one-twelfth of an inch, and have been carefully tested, with a view to bearing all the strain put upon them and maintaining a perfect tube. There is no ornamentation, by polishing or otherwise, except plain black paint. The weight of the tube is 2,000 lbs.

The telescope is equipped for photographic and spectroscopic work, and is very complete in all its appliances. One observer will be able to handle the great instrument easily and quickly, so fine and perfect are the adjustments and machinery. The difficulty met in observing a star when it is low in the heavens and the eye-piece is brought high above the floor is overcome by raising the floor by hydraulic rams. The observer touches an electric button in a keyboard by his side and raises or lowers the floor at will.

The clock is wound automatically by electricity. When the weights reach a certain point they switch on an electric current, which is cut off again when they are wound up.

The ease in handling the telescope is increased by the devices to reduce friction. The shaft of the polar axis rests on hardened steel ball bearings resembling those in fine bicycles, and at the top it works on a necklace of anti-friction rolls.—*New York Times.*

WING'S DISK FAN.

We illustrate two forms of disk exhaust fans made by L. J. Wing & Co., of 126 Liberty Street, New York. Fig. 1 shows the ordinary fan designed to be driven by a belt. The advantages claimed for this fan are that, inasmuch as the blades are curved and have an expanding pitch, the amount of air removed is increased, while the slippage is lessened. The amount of power required to run the fan is very little, and as the fan and its working parts are enclosed in a framework protected and held together by arms of wrought iron, there is no danger of accident.

The blades are also adjustable, so that they may be set to suit the conditions under which the fan is to operate, and it may be used efficiently under widely varying conditions. Its light weight enables it to be placed at either end or in the center of a pipe, in a wall, window, or door, where it may be run either horizontally or vertically as circumstances may require. Finally, it is noiseless. The applications of the fan embrace about everything where a draft of air is required, as in drying-rooms for silk and woolen goods, for removing steam, vapors, smoke, heat, gases, dust, acids, and for ventilating vessels, mines, and tunnels.

Fig. 2 illustrates a large fan with a special engine attached for driving it. The engine is placed on the fan-frame and connected to the shaft, thus forming practically a part of the fan. It is neat, compact and light, and runs with very little care, and is very desirable for places where there is steam but no engine, where the fan is to be placed in some isolated spot, or is to be run at night when the main engine is shut down, and is very convenient for night drying in factories or for heating buildings.

A Large Hydraulic Ram.—Rife's Hydraulic Engine Manufacturing Company, Roanoke, Va., has recently built a hydraulic ram which yields remarkable results. It is attached to an 18-in drive pipe with a 4-in. discharge-pipe, and weighs a ton. This ram, under a head of 7 ft., elevated a gallon of water per second to a height of 34 ft. It is said that during the experiment the ram took in the requisite quantity of air and worked very steadily and satisfactorily. It has thus been demonstrated that it is quite within the range of possibilities to make larger hydraulic rams than have heretofore been thought of.

Belt Railroad at Terre Haute, Ind.—There is a movement on foot at Terre Haute, Ind., to build a belt line connecting the various roads centering in the city. A charter was granted for such a road in 1883 for fifty years, but it was decided at that time that the city was unable to support such a road. Now, however, the city has so encroached on the yards, which were built outside of the city at that time, that the officials of the roads interested are strongly in favor of the line. It is estimated that the proportional cost to all the roads interested will be comparatively small, and that the location of the new factories will increase the rates and pay the cost of construction in a short time.

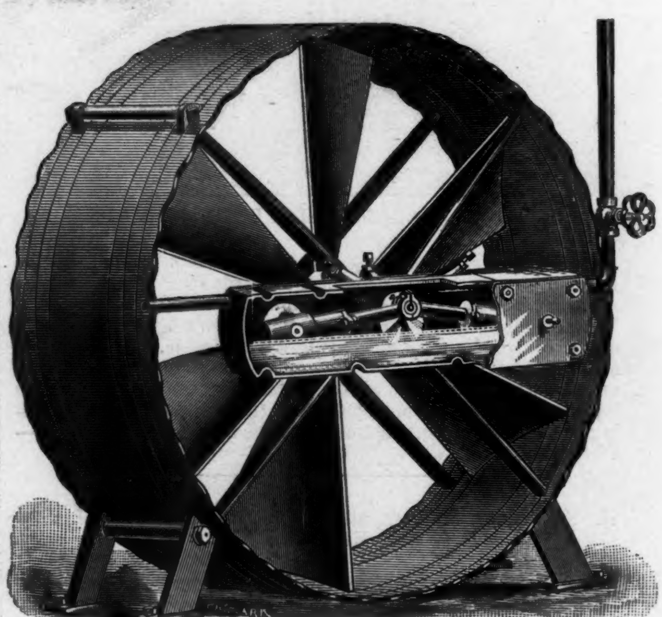


Fig. 2.

The Ajax Metal Company Incorporated.—This Company announces that the co-partnership heretofore existing between J. G. Hendrickson and F. J. Clamer, which has conducted its business under the name of The Ajax Metal Company, is this day dissolved by mutual consent.

The property and interests of said co-partnership have been acquired by The Ajax Metal Company, Incorporated, which will continue the business.

The officers of The Ajax Metal Company, Incorporated, are: J. G. Hendrickson, President; Francis J. Clamer, Vice-President; and J. R. Neison, Secretary and Treasurer.

The business will be carried on in Philadelphia as heretofore.